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LINKING FOR LEARNING

A New Course for Education

CONGRESS OF THE UNITED STATES OFFICE OF TECHNOLOGY ASSESSMENT

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A New Course for Education

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Foreword

Neighbors share resources and come together to create community, enhancing the special qualities of individuals while enriching the well-being of all. Electronic links, used for learning, are creating new neighbors among schools, classrooms, teachers, students, and other members of the community.

Rapidly developing telecommunications technologies, becoming cheaper even as they become more powerful, are changing American life. Enlisted over the past 5 years to meet the needs of geographically isolated schools, these technologies, united with trained and enthusiastic teachers, are beginning to enrich all our school environments. Another fascinating aspect of distance learning is that the private sector is an active participant, joining hands with educators, higher education, and government.

This study of distance learning was requested by the Senate Committee on Labor and Human Resources and endorsed by the House Committee on Education and Labor. OTA was asked to analyze various technological options, examine current development, and identify how Federal, State and local policies could encourage more efficient and effective use. This report complements OTA's assessment of use of computers in elementary and secondary education, *Power On! New Tools for Teaching and Learning*.

Throughout this study, the Advisory Group, workshop participants, and many others played key roles in defining major issues, providing information, and championing a broad range of perspectives. OTA thanks them for their substantial commitment of time and energy. Their participation does not necessarily represent an endorsement of the special report, for which OTA bears sole responsibility.

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NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory group members. The advisory group does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

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Chapter 1

Summary

Photo credit: Sal Sheg, The Daily Inter Lake, Kalispell, MT

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Chapter 1

Summary

INTRODUCTION

"Ohayoo gozaimasu, Moore-san." So began the warm-up exercises in Japanese between Mississippi 12th grader Albert Moore and his telephone instructor, Chizuko Takechi in Omaha. For 1 hour a day, 2 days a week Albert practiced his spoken Japanese with Mrs. Takechi over the telephone. On alternate days, Albert participated in the Japanese class taught live via satellite from the Nebraska Educational Television studios in Lincoln, Nebraska. Albert and his counterparts in Houlka, Iuke, North Forrest, and South Panola High Schools were part of a small group of Mississippi students able to take the course. According to Albert, distance learning presented both challenges and opportunities:

> There is no teacher to hang over our shoulders, so we have to supply our own motivation and desire to succeed in the class ... [at the same time, this experience] provided me not only with classes I would otherwise not be able to take, but an opportunity to work with some of the most advanced technology of today, which is a learning experience within itself.[1]

On the last day of the school year, the 9,000 teachers and administrators from every school in the Dallas Independent School District came together to discuss AIDS, a growing crisis in their community. Not even the convention center could hold the group, and there were clearly not enough experts in the community available to travel to each of the 235 schools in the district to discuss the topic in the single day allotted for inservice training. The district's solution was to use the cable system recently installed in all school buildings to link all the teachers and experts at the same time. During this day-long meeting, time was set aside for each expert to discuss AIDS and its implications, for educators to react after each presentation, and for questions from the sites and answers from the experts.[2]

Next February, as the school day winds to a close, a small group of high school teachers will sit together in a classroom in their school located in remote northern Maine. They will begin a graduate class in teacher education taught from the University of Maine campus located 150 miles to the south. Instead of having to drive 4 or 5 hours each way in snow and subzero temperatures, along secondary country roads, these teachers will take this class without having to leave their own school building. Using the Community College of Maine/Telecommunications System, they will see and hear their instructor and discuss educational concerns with her and fellow teachers on campus and at other school sites. The format for this class will be repeated in other offerings for high school students, college students, and adults in Maine who will have the equivalent of a community college system for education and professional training. Special seminars, workshops, and meetings will also be offered.[3]

In these examples of distance learning, technology transports information, not people. Distances between teachers and students are bridged with an array of familiar technology as well as the new machines of the information age.[4] What sets today's distance education efforts apart from previous attempts is "... the possibility of an interactive capacity that provides learner and teacher with needed feedback, including the opportunity to dialogue, clarify, or assess."[5] Distance learning relationships can be maintained in many ways from the simple exchanging of printed material via post or facsimile to two-way interactive, cross-continental television or computer networks. New technological advances and reconfigurations and combinations of older technologies offer an expanding array of learning options. Distance learning has changed dramatically in response to new technologies and new needs. Technologies for learning at a distance are also enlarging our definitions of how students learn, where they learn, and who teaches them.

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[1] Albert Moore, testimony before the Senate Subcommittee on Education, Arts and Humanities of the Committee on Labor and Human Resources, field hearing, Jackson, MI, Apr. 27, 1989.

[2] Diana Radspinner, cable communications coordinator, Dallas Independent School District, personal communication, July 1989.

[3] In September 1989, the Community College of Maine/Telecommunications System became operational in 23 high schools, all university campuses, 11 off-campus centers, the vocational/technical institutes, the Maine Maritime Academy, and the Maine Public Broadcasting Network through a mix of leased fiber optic cable and construction of a microwave and Instructional Television Fixed Service network. Courses can be transmitted from any campus to the off-campus centers and high school sites in its region or to all locations throughout the State. See University of Maine at Augusta, *Community College of Maine Newsletter*, March, May, and September 1989.

[4] Jason Ohler, University of Alaska Southeast, "Distance Education and the Transformation of Schooling," OTA contractor report, May 1989.

At the request of the Senate Committee on Labor and Human Resources, the Office of Technology Assessment (OTA) examined the use of technology for distance learning to improve the quality of education for students and training for teachers. OTA analyzed the technological, economic, institutional, and policy barriers to further development of distance learning. This study focused principally on applications in elementary and secondary (K-12) education. Distance learning is defined in this study as the linking of a teacher and students in several geographic locations via technology that allows for interaction.

OTA finds that while distance learning initially served isolated rural schools and some urban systems, current uses go beyond these needs. Systems carry advanced and specialized courses and training and seminars for teachers. They link learner communities with each other and bring a wide array of experts and information to the classroom. If distance education is to play an even greater role in improving the quality of education, it will require expanded technology; more linkages between schools, higher education, and the private sector; and more teachers who use technology well. Federal and State regulatory policies will need to be revised to ensure a more flexible and effective use of technology for education.

DISTANCE LEARNING TODAY

Distance learning in K-12 education has increased dramatically over the past 5 years. Five years ago, few States or districts had either projects or plans for distance education at the K-12 level. Fewer than 10 States were promoting distance learning in 1987; 1 year later two-thirds of the States reported involvement.[6] Today virtually all States have an interest or involvement in distance education. Within States, a growing number of efforts involve local districts, regional education service centers, nearby universities, and community colleges. At the same time, an increasing number of districts are using services offered by public and private educational telecommunications providers. These multistate projects have experienced dramatic growth in student enrollment.[7] The Federal Star Schools program, begun during the 1988-89 school year, established a new multistate network and greatly expanded three others. **Nevertheless, many students and teachers do not now have access to needed but distant resources.**

Although spotty in terms of national distribution, distance learning has been aggressively adopted in many areas due to two factors:

- **Specific educational needs can be met.** One need is the provision of instruction in mandated courses or advanced, specialized courses in schools where teachers are not available or are too costly to provide for a limited number of students. A second need is the provision of training and staff development for teachers in locations where experts and resources are difficult to obtain.

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[5] Dean Bradshaw and Patricia Brown, *The Promise of Distance Learning*, technical paper (San Francisco, CA: Far West Laboratory, 1989).

[6] National Governors' Association, *Results in Education: 1988* (Washington, DC: 1988), p. 29.

[7] In 1986 when the Satellite Telecommunications Educational Programming Network began operation, it offered 5 high school courses to 13 school districts in Washington State. Only 2 years later, the network served more than 800 students in 58 school districts in 8 States.

SUCH SHORT LATIN PHRASES
AS THESE ARE IN DAILY USE
magnum bonum
prima facie
modus operandi
sub rosa
inter nos
ad nauseam
alter ego
in medias res
casus belli
cum grano salis
Dei gratia
Deo volente
disjecta membra
ante bellum

Photo credit: Kenai Peninsula Borough School District, Soldotna, AK

Students at Homer High School on Alaska's Kenai Peninsula can study Japanese, thanks to a course delivered by the Satellite Telecommunications Educational Programming (STEP) Network in Spokane, Washington.

- **Recent rapid development of technology has resulted in systems that are powerful, flexible, and increasingly affordable.** The base of available technology resources is increasing. Information technologies continue to develop with dramatic speed. Possibilities for audio and visual interaction are increasingly wide. Much has been learned about connecting various forms of technology into systems, so that the ability to link systems one to another is growing.

Meeting Educational Needs

State-mandated curriculum reform, especially increased requirements for high school graduation or college admission, is driving many efforts. For example, the Oklahoma State University's Arts and Sciences Teleconferencing Service (ASTS) began to offer *German by Satellite* in 1985 in response to requests from local districts seeking help in meeting new State foreign language requirements. This provider and others have responded to similar needs in other States (see box 1-A). At the same time, some districts have created local and regional distance education applications to share their existing pool of teachers and students more efficiently and meet new requirements.

Maintaining quality within the teacher work force requires up-to-date skills and information;

Box 1-A—Satellite Telecommunications Educational Programming Network

"Live! Via satellite from Educational Service District 101 in Spokane Washington! It's Advanced Senior English!" So began the start of class last fall for Heather Lowes, a student at Warrenton High School in Astoria, Oregon, and her fellow students.[1] In this case, however, Heather was the only student in the classroom—her "classmates" were students located in about 80 other high schools spread across an eight-State area. Although physically separate, these students shared one teacher, Penny Cooper, who greeted them each morning in her Texas drawl with an enthusiastic "Waaall, good morning!" They also shared the demanding curriculum, which meets the content requirements of many college humanities courses and prepared Heather and her peers to take the Advanced Placement examination in composition.

With such a large and diverse "classroom," Ms. Cooper had to find new techniques to involve individual students and make everyone feel a part of the class. For example, while leading a discussion on *The Iliad*, she paused to ask various students to phone her on the toll-free 800 number to ask questions; as the students responded, their schools' names were flashed in large letters on the screen and their home State was superimposed on a map of the United States. Other students can call the part-time assistants (called TAGs— "telephone answerers and graders") who answer questions raised by students and classroom facilitators and help grade student papers. From Monday to Thursday the students participated in the 50-minute satellite class, with Fridays set aside for the students to take tests previously sent from Ms. Cooper, review content, or complete individual or group assignments. Because classes are sometimes missed due to illness or scheduling conflicts in the home school (e.g., sports activities and assemblies), Fridays are also used as makeup days, when students can catch up by viewing a tape of the missed session.

Similar scenarios occur each day in high school classes all across the Northwest in the schools subscribing to the Satellite Telecommunications Educational Programming (STEP) Network. Like many distance learning systems, STEP was created to meet a relatively localized but common problem. School superintendents in Washington's Educational Service District (ESD) 101 service area needed help in delivering high school credit courses in subjects where they were unable to provide certified teaching personnel. They went to their ESD, which traditionally acts as a liaison between local school districts and the State education department and assists local schools in meeting instructional and administrative needs.

In considering distance education as a way to meet the need for courses, a number of technologies were considered. Satellite was chosen because ESD administrators wanted the capability to broadcast to the entire State of Washington, and because, fortuitously, an uplink capacity was available through Eastern Washington University (EWU) in Cheney, 20 miles south of Spokane. An agreement was reached with EWU and in September 1986 four high school courses were broadcast from an EWU studio to 18 sites in Washington. By the end of the second year,

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[1] This example is taken from John Forumoyer, "Youths' Lofty Goals Met Via Satellite," *The Daily Astorian*, Astoria, OR, Sept. 22, 1988, p. 3.

changing demographics and curriculum reform give urgency to professional and teacher education efforts. Technology can be a tool to reach teachers with training, information, and resources that enhance their skills and expand their knowledge. The National Aeronautics and Space Administration (NASA) teleconferences via satellite, the Dallas district inservice training via cable, the Maine telecommunications system, and efforts under the Star Schools program are examples. Technology allows teachers to meet and talk with national experts, visit other classrooms, take courses, or collaborate with teaching colleagues 5 or 5,000 miles away.[8]

Distance learning networks that provide courses can also bring people and experiences to the classroom to expand traditional instructional practices (see box 1-B) or provide entirely new alternatives. Networks that connect classrooms to the home, business, and locations in the community provide ways to reach parents, offer

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[8] For example, expert teachers in Iowa welcome prospective teachers into their classrooms via satellite, while two teachers in Connecticut join classrooms via a fiber optic network to team teach and build on their students skills: one group with expertise in Spanish grammar and literature, the other group with native language fluency and culture.

STEP had a membership of over 40 districts, including several in neighboring States and a modern uplink and production facility, the result of a partnership formed between ESD 101 and RSL Communications. Today there are over 100 STEP subscribers in 12 States.

STEP operates as a public, nonprofit cooperative. Costs are distributed among users. The operational budget is financed from the subscribing districts through installation, annual subscription, and tuition fees. While the director's salary is paid by ESD 101, all other costs (teachers' salaries, production costs, TAGs, and other support costs) are financed through member fees. According to the director: "No special funding—not one dime—has come from State or Federal sources to support STEP programming."[2] ESD 101 makes available to new subscribers an equipment package that includes a downlink satellite dish and associated television classroom and telephone equipment and maintenance. Districts can also make arrangements to obtain their own equipment. In either case, first year capital equipment items required typically range between $5,000 and $6,000.[3] New members pay a $4,750 initial membership fee, which is renewed at $3,000 per year. Interestingly, membership fees for districts who elect not to receive staff development are higher, $6,000 for the first year and $4,750 each additional year. Charges for high school credit courses are based on a per student, per course, per year fee. Courses include Japanese I and II, Spanish I and II, Calculus, and Advanced Senior English.

Enrichment courses are also offered, and reach down into elementary and middle schools. These programs are broadcast on Fridays, when regular STEP classroom instruction is not being broadcast. Student enrichment programming is optional, assessed at $350 per program or $1,000 for a total package of 10 programs.

As the fee schedule indicates, staff development is an important part of STEP programming. Course credit is available through EWU and Whitworth College, or teachers may take the courses for "clock hours" credit for advancement. Efforts are under way to make it possible for teachers to complete a master's degree program via distance learning.

In the future, STEP programming and services may become part of a national network of similar providers. A step in that direction will begin in fall 1989 when the TI-IN Network markets the STEP calculus course to its subscribers. "We would hope that there is more coordination between vendors, higher education, and the public schools, so that we could each exploit our strengths and offer affordable and high-quality services on a nationwide basis."[4]

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[2] Ted Roscher, ESD 101 STEP administrator, personal communication, in Bruce Barker, Texas Tech University, "Distance Learning Case Studies," OTA contractor report, June 1989. In 1988, STEP applied for a grant under the Federal Star Schools legislation, but was not selected for funding.

[3] STEP recommends a 2.8-meter steerable downlink dish that is equipped with both a Ku- and C-band feedhorn, so local schools will then have the flexibility to pick up additional satellite programs besides STEP. Barker, op. cit., footnote 2.

[4] Ted Roscher, ESD 101 STEP administrator, personal communication, Aug. 30, 1989.

after-school help with homework, or form new communities of learners (e.g., students, parents, business leaders, and librarians). In the future, a number of large urban districts plan to build their own network so that common needs and rich resources can be shared.[9]

Distance education makes feasible the linking of all levels of education—elementary, junior, and senior high to higher and continuing education. This fact has great significance because of the widespread current interest in restructuring many aspects of education. Distance learning networks that link universities, schools, and informal learning institutions, such as museums and public libraries, lead not only to expanded services but to new relationships.

OTA finds that successful applications of distance learning have been shaped by the

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[9] Public school administrators in Chicago, Dallas, New York City, Philadelphia, and San Francisco have formed the National Education Technology Trust (NETT), a consortium to establish a video/data communications network "... that will provide a link between students, staff, parents, and community members from large cities across our nation." Bernard Solomon, The School District of Philadelphia, personnel communication, July 5, 1989.

Box 1-B—The Telelearning Project

The Telelearning Project, administered by the Delaware-Chenango Board of Cooperative Educational Services (BOCES), is one of the pioneer distance learning projects in New York State. Begun in 1985, this audiographics network links 10 of the 18 school districts throughout this rural area of dairy farms and gently rolling hills, located about 50 miles northeast of Binghamton. Many of the 44 schools in the region are small and have had difficulty providing a full curriculum; many of the students have had little exposure to the world outside of the small villages that make up their remote communities. Sharing instruction via audiographics became an attractive means to expand high school credit offerings and to enhance educational opportunities for students.

In each of the first 3 years of operation, approximately 40 students at about a dozen schools took advantage of the three to five courses offered on the system. Last year only two courses were offered and student participation dropped to 15 students from 10 participating schools. The reasons for the decline included problems in scheduling, changes in the New York Regents core curriculum requirements, four different project administrators in as many years, and decreased State aid for schools, which made it difficult for some schools to pay membership fees and program costs. One of the key problems was teachers:

> When we first started the project we hired outside teachers (from the nearby university) who did an excellent job and excited students. Because of teacher union concerns the second year, we released these people and hired teleteachers within the ranks of teachers already teaching in schools serviced by the BOCES. Several of the teachers did not adapt well to the technology. Consequently, the students were not as enthusiastic as they had been.[1]

The current Telelearning Project coordinator has made teacher training a high priority, and is optimistic for the future. "In the last couple of months we've trained 10 teleteachers. We now have a cadre of personnel who want to teach telecourses and know how to do so effectively. With quality teleteachers teaching courses, the program will sell itself among students, other teachers, and administrators."[2]

Two schools have used audiographics to teach homebound students. At one school, an eighth grade student was given audiographics equipment to use at home while recuperating from back surgery. The computer, graphics tablet, and speaker phone made it possible for him to take his regular classes from his bed, to participate in class discussions, not fall behind in his work, and keep up with his friends during this difficult time.

The project has also made possible the increasingly popular "electronic field trip." An electronic field trip is a telephone conference call from one of the schools in the project to an outside authority or classroom. Over 50 of these field trips are conducted by participating schools in the BOCES region each year. The BOCES administrator explains the appeal: "Rural students are so isolated and have so little, if any, cross-cultural contact. One of the(ir) major needs is to come in contact with other people in other areas. The electronic field trip is a very simple and inexpensive way to give students contact with experts in a variety of areas."[3] The calls can be as close to home as

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[1] Freeman Van Wickler, executive officer, Board of Cooperative Educational Services, personal communication, in Bruce Barker, Texas Tech University, "Distance Learning Case Studies," OTA contractor report, June 1989.

[2] Linda Gorton, telelearning project coordinator, personal communication, in Barker, op. cit., footnote 1.

[3] Van Wickler, op. cit., footnote 1.

needs and objectives of education. Today's technology makes it possible to meet these needs in new ways.

Advances in Technology

Advanced technological capability at lowered costs increases the options for distance education. **Most distance learning systems are hybrids, combining several technologies, such as satellite, Instructional Television Fixed Services (ITFS), microwave, cable, fiber optic, and computer connections.** New developments in computer, telecommunications, and video technologies continue to expand the range of choices, and new strides in interconnecting systems are being made regularly.

The technology is flexible. Existing technology resources in a community are most often the starting point for system development. Even though cable systems now reach many commua sixth grade class interviewing the mayor of Binghamton, or as far away as students in classrooms in Australia, Alaska, South Africa, and England. Students on electronic field trips have contacted social activists, artists, authors, historians, steel mill workers, and even a famous rock musician.

What is the benefit provided by electronic field trips? Some teachers have their doubts, commenting ". . . that they were not prepared to spend an hour of their class time in order to prove the electronic wizardry of telecommunications."[4] Yet, a case study in which eight students spent several weeks preparing for their 1-hour interview with a rock musician, suggests that with proper preparation, the students can benefit in many ways when the outside world can be beamed in to them.[5] Listen to Bob, a student generally not particularly interested in school:

> On Monday it was hard to pay attention during class. All I could think about was the interview . . . .But this day was different. At the end of the day we got out of class a little early and set up the equipment for the (conference) call. Some of the teachers and even parents came to listen to the interview.

Bob and seven other students were about to meet with Paul Kantner, a musician and rock-and-roll star who has played with the Jefferson Airplane, the Jefferson Starship, and most recently a band known as KBC.

Although originally about 25 students expressed interest in participating in the interview, only those who were serious enough to do a background research paper were selected. These eight students, a mixed group of aspiring musicians, college-bound high achievers, and regular kids with no idea what their future may hold, threw themselves into the project with enthusiasm uncommon for teenagers. One described the interview:

> We were all seated at this table; the school board members allowed us to use their meeting room. We had been preparing for this interview with Kantner for over 2 weeks. When we started the interview I had my five questions but we talked so long I had to think up six new ones. We talked over an hour and 15 minutes. I think Paul Kantner would have talked longer. He was great because he really talked to us. He asked us questions and then listened to our answers.

When asked about their preparation, the students noted proudly: "The research was really important because it helped us ask intelligent questions." The music teacher, the Telelearning Project coordinator, and the librarian all worked closely with the students in the weeks prior to the actual interview. And, when the interview was over, the students' enthusiasm lived on. "Kantner spoke to us about things that were important to us." "We would like to talk with another musician who has not made it big and compare the interviews." "My friends asked me about my interview, even my parents asked." "It has made school really special for these few weeks. I still get excited when I think about it." They had only one regret: ". . . even our local paper hardly reported what happened. If this had been a local football game they would have given it two columns of reporting. We hardly got mentioned."

These students were justifiably proud of the work they had done to make the electronic field trip a success. Like the football players who get the press coverage, they too had worked hard to win their goal. In the process, they had learned planning skills, how to organize their thoughts both on paper and on their feet, found out about a career to which some aspire, and learned to work as a team. As the researcher noted: "While the actual interview was a little like a familiar telephone conference call, the result was nothing like a casual conversation with a friend."

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[4] Patrick Galvin, *Telelearning and Audiographics: Four Case Studies* (Ithaca, NY: Cornell University, June 1987), p. 11.

[5] The following section and quotes are all taken from ibid.

nities and the telephone network is ubiquitous, few classrooms have the basic wiring required to take advantage of this telecommunications base. And while satellites can reach locations thousands of miles apart, less than 10 percent of all school districts have the equipment to receive programming.

The schools' desire for technology resources comes at an opportune time. Educational requirements for infrastructure coincide with a growing demand for telecommunications capability and services coming from all sectors of society. **Education needs that parallel the needs of business, government, and health care providers create an opportunity to share costs. Even more important, this paralleling of needs has stimulated an active marketplace for hardware and services that has brought industry and the private sector to the door of the education community.** The capability of the technology, and its special ability to

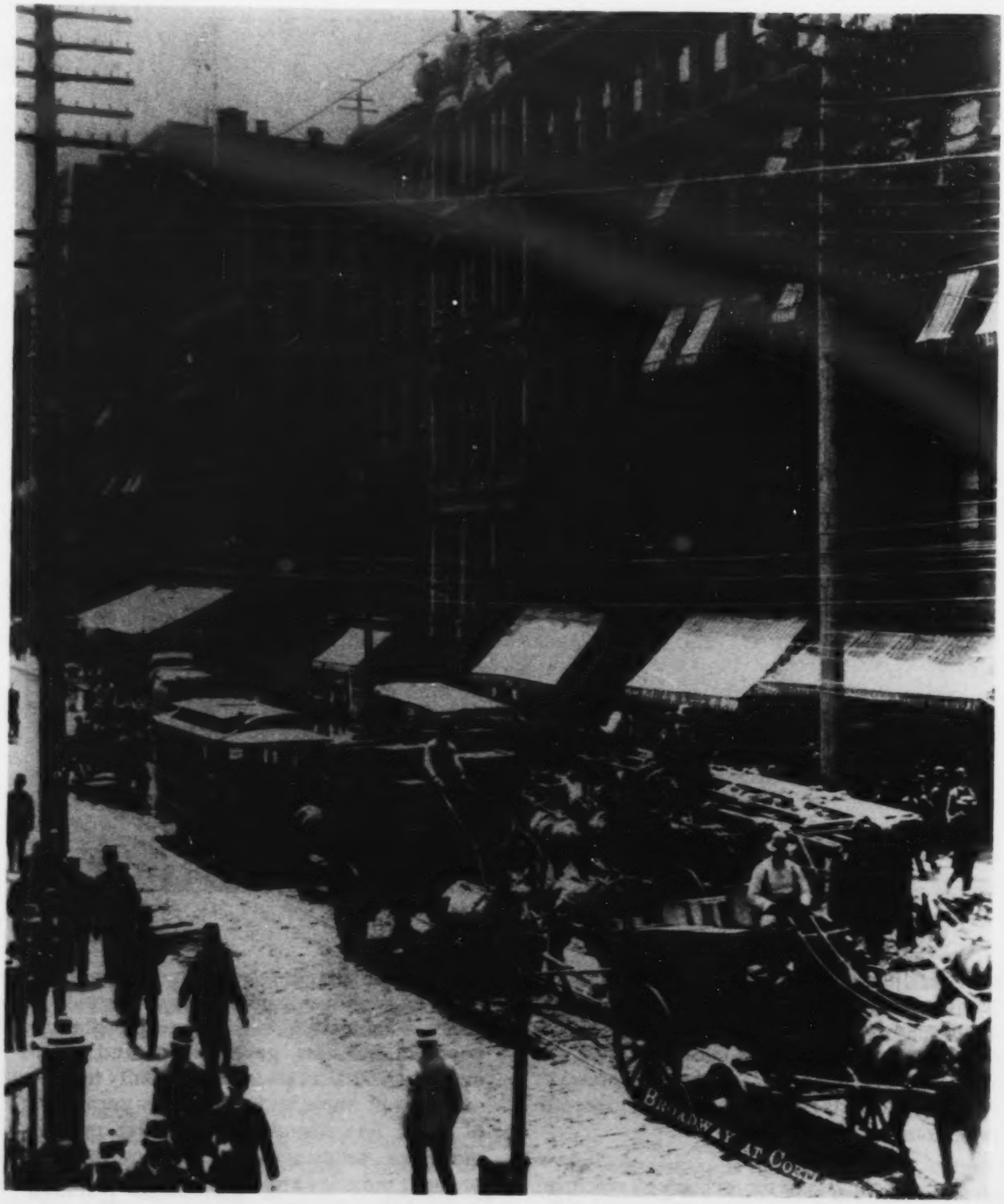

Photo credit: AT&T Photofile

Our telecommunications links have come a long way from the era of the horse and buggy.

link groups of users, is creating many commercial activities and broadening markets in which education is a key player.

EFFECTIVENESS

In most instances, distance learning appears to be as effective as on-site, face-to-face instruction in the classroom. Extensive research indicates that distance learning is equally effective in applications for adult learners in nontraditional programs and for training of professionals in business, industry, and the military.[10] Distance learning has proven to be a powerful delivery system for many subjects and through many media. Although the evidence is incomplete in K-12 education, studies point to the need for competent teachers, valid instructional models, and appropriate institutional support. The recent development of distance learning in K-12 settings means that much must be learned about instructional design, teaching techniques, and various kinds of interaction that affect learner outcomes. Current distance learning efforts offer a rich source of data to be mined.

Distance learning affects the educational process in a number of ways. Students report having to take greater responsibility for their learning and that their experience helps them make the transition to higher education. Students also report that they benefit from exposure to a greater range of ideas, peers, and teachers made possible by the expanded educational community. At the same time, however, students report that distance learning is harder. When the distance learning group is large, students complain about difficulties in raising questions and obtaining help during class time.

Whether distance learning works equally well for all students is yet to be determined. Most applications to date have been with academically advanced high school students and independent adult learners—those who already possess strong study skills, high motivation, and discipline. Whether the medium of distance learning works as well with young or academically weak students—and under what conditions—needs further study.

Adult distance education is cost-effective when compared to traditional methods of instructional delivery, saving on travel and employee time. Experiences in adult learning and business and military applications have implications for teacher training and staff development. Few studies have examined cost-effectiveness of K-12 projects. Where traditional instruction is simply not available, comparisons of cost-effectiveness of distance education and traditional delivery are moot.

Many States and localities have plans to implement systems in the near future. **The next 5 years thus present a critical window of opportunity, while investment decisions are being made, for evaluation of and experimentation on distance education in K-12 settings.** Research on technology-mediated learning and interactivity, instructional design and innovative approaches, and applications of cognitive theory represent good investments for the Federal Government in order to meet the long-term needs of the field. Evaluation would be most usefully concentrated on practical questions about educational quality, such as what are the learner outcomes of various teaching techniques and technology models.

THE ROLE OF TEACHERS

The critical role of teachers in effective learning means that all must have training, preparation, and institutional support to successfully teach with technology.[11] Distance learning has dual impacts on teachers: as a tool for teaching and as a means to upgrade their own skills and professional development. **Few teachers have had either teacher education or**

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[10] See Michael Moore, Pennsylvania State University, "Effects of Distance Learning: A Summary of the Literature," OTA contractor report, May 1989.

[11] See U.S. Congress, Office of Technology Assessment, *Power On! New Tools for Teaching and Learning*, OTA-SET-379 (Washington, DC: U.S. Government Printing Office, September 1988), ch. 5.

Photo credit: Apple Classroom of Tomorrow, Cupertino, CA

Students look up information in a database and share their work with others on the electronic network, developing skills in communication and cooperation as they conduct their research. These activities spark self-reliance and excitement for learning.

field experiences that enable them to be effective distant teachers or successfully use technology in their own classroom.

Although it is the technology that removes barriers and expands opportunities for learning, it is the teacher who teaches. In distance learning, teachers find that they are required to change their method of teaching and give more attention to advanced preparation, student interaction, visual materials, activities for independent study, and followup activities. Many distance education teachers report that the experience has improved their teaching skills. It has forced them to become more organized and has challenged them to become innovators.

Teachers who work with other colleagues via distance learning systems are finding opportunities for new relationships: sharing parts of a course, team teaching, and learning from master teachers. The technology itself could be a mechanism for boosting the professionalism of teachers, by fostering access to experts and making high-quality training and professional development available to teachers wherever they are located. It can also aid in the process of learning how to be a teacher (see box 1-C).

Teacher concerns about being replaced by technology must be taken into consideration in planning distance learning efforts. Teachers are concerned about the quality of instruction and the need for interaction with students. Involving teachers and the teacher unions early in the process can help to allay these fears when teachers see the opportunities created by distance learning. **Teacher input not only shapes development, it assures long-term support.**

Box 1-C—Teacher-LINK: An Electronic Network for Prospective Teachers[1]

The Curry School of Education at the University of Virginia created Teacher-LINK, an electronic bulletin board system, to link student teachers in the field with their university professors. The system is supported by a $1 million equipment grant from IBM, $15,000 in conferencing software donated by Metasystems Design Group, and a grant from the Centel telephone company to defray part of the cost of installing phone lines in teachers' classrooms. The remaining costs have been absorbed by the school systems.

Students receive an account on the network when they enter the Curry School of Education, and their accounts are retained until a year after graduation.[2] They can communicate with professors, classmates, professors at other schools of education, and classroom teachers. At the university, students access the communication system through a number of public computers in the education building and in their dormitories. During the teaching internship, they exchange lesson plans with advisers, obtain support from peers during difficult periods, and share teaching and curriculum ideas with others. It is hoped that ". . . by graduation, they will use the network as fluently as the blackboard and become the first generation of teachers trained to use an extended academic community as an instructional resource."[3]

One faculty member noted these benefits:

> Because I have different students, in different schools, teaching at different times, it is not easy to set up an efficient observation schedule by using the telephone. The electronic mail system has made the task of scheduling very easy. I can coordinate all my observations and also schedule around tests and quizzes, school assemblies, and other non-instructional sessions.[4]

About 80 teachers and 40 student teachers in 2 local school systems are now linked on the system. By 1990, the Curry School expects to link all the student teachers in the seven participating school districts. Future plans call for a computer network between the University of Virginia and local schools across the State that can be accessed by a local telephone call.

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[1] Earl Dowdy, University of Illinois, Urbana, "Computer Networks in Elementary and Secondary Education" (NTIS order number PB 88-194 675/AS), OTA contractor report, October 1987. Also James Cooper, dean, Curry School of Education, University of Virginia, Charlottesville, personal communication, July 1989.

[2] Much of this discussion comes from Glen Bull et al., "The Electronic Academical Village," *Journal of Teacher Education*, in press.

[3] Ibid., p. 16.

[4] Ibid., p. 9.

STATE ROLES AND CHALLENGES

States are key players in distance education. States are important because they set policy that shapes what is taught, who can teach, and what students learn. States provide funding and they also regulate telecommunications. In some cases, they develop statewide networks. Planning for the Iowa telecommunications network illustrates the importance of State leadership and support (see box 1-D).

State responsibility for teacher certification, curriculum, and evaluation brings States directly into the development of distance education—particularly efforts that cross local district boundaries. Once efforts cross State boundaries, differences in State requirements and guidelines can present barriers to development—or opportunities for flexible new arrangements. States and local districts that want to use out-of-State resources have had to bend the rules or adopt interim policies, and have in some cases been thwarted.

Increasing the utility of distance education, accessing a wider range of instructional resources, and developing creative solutions to meet educational needs will require a reexamination of State policies, rules, and regulations that were written in the context of traditional educational settings. States may need to revise their definitions of classroom location and course credit, instructional roles, and funding formulas. Equally important, States may want to develop new standards and criteria for certification of teachers and evaluation of

Box 1-D—An Information Highway for Iowa[1]

> More and more States are recognizing that telecommunications systems are the highways of the 21st century. A good telecommunications system can make rural Iowa a logical choice for a business location or expansion. It can also help our schools prepare students to compete in a world economy.[2]

Iowa had a head start in educational telecommunications because of the pioneer efforts undertaken in the 1970s by Kirkwood Community College to reach beyond their local campus and provide courses to students in outlying communities. In the process of expanding its services to a broader audience of students, Kirkwood established relationships with other colleges, secondary schools, business, industry, labor, and the telecommunications industry. These partnerships were a key to Kirkwood's success.

Over the last decade, other community colleges, universities, and secondary schools in the State followed Kirkwood's lead and built or planned educational telecommunications systems of their own. By 1986, the Iowa General Assembly decided that statewide direction was needed. A goal was established to extend what was offered in better served portions of the State to those not reached by the community college or university system, and to extend educational links to elementary and secondary schools. Planning began in December of 1986; 8 months later a formal report outlining the Iowa Educational Telecommunications Plan was presented to the legislature.

The first step was to meet with educators at all levels across the State. At these meetings top officials of the State universities, the community colleges, the area education agencies, school districts, and businesses discussed their separate and common concerns and identified regional resources that could contribute to the system. In order to provide a common definition, a manual was prepared to give the organizations involved a better understanding of the technology systems available. These meetings caused potential users to look beyond their immediate needs and helped solidify support for a statewide telecommunications system.

Organization was the next concern. Because of their extensive community contacts, the 15 area community college districts were chosen as hubs for the system. The community colleges created a planning framework integrating educational telecommunications in their mission statements and confirming their willingness to become coordinators for their geographic area. Each of the other educational organizations in their regions were consulted to assure that they were comfortable with the community colleges' coordinating role.

One institution at the State level was needed to coordinate the entire system. Because it already had statutory responsibility for telecommunications, Iowa Public Television (IPTV) was considered the most viable organization to provide that coordination. A Narrowcast Advisory Committee that includes IPTV, representatives of the 15 area groups, and all other users was formed. The committee serves as a place where differences among users are aired, problems are resolved, and operational procedures and fees for the use of the system are set.

Local involvement in the planning process was high, fostered by town meetings to explain what was being planned and ways it could serve the community. These grass roots discussions encouraged a spirit of cooperation critical to the success of the project.

After all portions of the State were surveyed, a Request for Proposal (RFP) was sent out for bids on a statewide system with the capability of communicating on a local, statewide, regional, national, and international basis. The system called for the use of multiple technologies including microwave, Instructional Television Fixed Service (ITFS), fiber optics, and satellite. The RFP resulted in an award for the fiber optic portion of the system for $60 million; $20 million for the backbone system and $40 million for telelinks to the other sites—links consisting of microwave, ITFS, and cable systems. However, a recent challenge to the RFP and contract award was successful and, as a result, the RFP is being revised and the contracting process will be recompeted.

In the meantime, the legislature has awarded $50 million to fund the plan, and negotiations are expected to move forward. The Governor has made the educational telecommunications plan a linchpin to Iowa's economic growth.

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[1] Much of this discussion comes from Larry G. Patten, "Future Technologies," OTA contractor report, May 1989; and OTA site visit, March 1989.

[2] Terry Branstad, Governor of Iowa, "Condition of the State," speech delivered to 73rd General Assembly, Jan. 10, 1989.

students to assure that the quality of educational services is maintained or improved through the use of these resources.

In many States, impetus for distance education is coming from the State legislature, the Governor, the higher education commission, or the State education agency. In practice, the locus of control over distance education varies from State to State, and responsibility for educational telecommunications may reside within the State education agency or outside it. **Educational leadership will be a critical factor for planning efforts that draw together public and private sector interests, use resources efficiently, and meet a broad base of educational needs.** Interagency cooperation, shared cost arrangements, and connections between secondary and higher education are benefits of statewide efforts.

Telecommunications regulations that are most critical at the State level were not developed for distance learning. For example, State regulators control the pricing of telephone services as well as the development of the local telephone infrastructure. If States are concerned about effective use of telecommunications resources in distance learning, regulations and policy will need to be revisited.

Photo credit: South Carolina Educational Television

This school, a site for the Federal Star Schools grant to the Satellite Educational Resources Consortium (SERC), offers Russian to its students.

FEDERAL ROLES AND REGULATIONS

Though important, the Federal role in funding distance education has been modest and has come from several diverse programs, most of which were not targeted to distance learning in K-12 education. Growth of distance education can be expected to continue for some time without increased Federal involvement. **A commitment to a major development, however, such as a national telecommunications infrastructure for distance learning, will require a change in the Federal role.**

Federal funding for the Star Schools Program has accelerated the growth of distance education in the United States through direct purchasing power as well as the familiar leveraging power of Federal money. Star Schools funded the development of four multistate, public/private partnerships for distance education, establishing one new network and greatly expanding three others. The Star Schools legislation, and the national attention it gave to distance education, served as a catalyst for planning and development beyond the projects that were funded in the first round. This groundswell of interest, enhanced by 2 subsequent years of planning and experience should manifest itself in an even greater interest in the second round of Star Schools funding. A total of $100 million was originally authorized over a 5-year period; approximately $67 million remains after the first 2-year cycle of grants.

Several Federal programs provide funds for distance learning hardware. The Public Telecommunications Facilities Program at the National Telecommunications and Information Administration, established in 1962, has funded the purchase of equipment used in distance

Box 1-E—The Jason Project[1]

Last May, a quarter of a million students in grades 4 to 12 explored the floor of the Mediterranean Sea as participants in the Jason Project. Their guide was Dr. Robert Ballard, discoverer of the sunken Titanic and marine geologist at the Woods Hole Oceanographic Institute. Ballard conceived of this project as a way to expose students to the actual process of scientific discovery, igniting their interest in science as an exciting career. As the remote-controlled robot vessel, the JASON, skimmed along the floor of the Mediterranean, its cameras sent live video images via a fiber optic cable link to the mother ship. (See figure 1-1.) Ballard and the other scientists on the ship recorded and interpreted for the students the archeological artifacts and oceanographic wonders being seen for the first time. These live images were sent by international satellite to an Earth station in Atlanta for transmission to science museums in the United States and Canada. Each of the 12 science museums in the Jason network had a command center mock-up replicating the shipboard command center. The student undersea explorers had studied a specially developed curriculum in science, social science, and history prior to attending the museum event. Each class expedition lasted 1 hour and included taped background materials, as-it-happens viewing of the scientists and the marine environment they were exploring, and question-and-answer sessions with Dr. Ballard and the crew.

The Jason Project is a partnership among many sectors. Woods Hole Oceanographic Institution, a private nonprofit marine research facility, is the coordinating organization for the project, and also is responsible for the 7-year development of the ARGO/JASON vehicles (funded by the Office of Naval Research). Electronic Data Systems provided the communications technology, equipment management, and staging at each museum site, as well as substantial funding contributions. The Quest Group, Ltd., a group of private individuals highly supportive of deep-sea exploration, is underwriting part of the project costs. Turner Broadcasting coordinated the live and preproduced portions of programming at a reduced fee. The National Geographic Society, producers of a film on the project, coordinated the involvement of the 12 museum sites around the country. National Science Foundation funding went to the National Science Teachers Association, which wrote the science curriculum for the project, with help from the National Council for the Social Studies. The total project budget was about $7 million, approximately three-quarters of which was for equipment and curriculum development, start-up costs that would not require support in future years. All parties are committed to doing the Jason Project again next year, using Lake Champlain and Lake Ontario as the sites for exploration.

The Jason Project is inspired by the advanced technology for seafloor exploration found in the ARGO and JASON systems developed by the Woods Hole Oceanographic Institution. The ARGO system, used to locate the wreck of the Titanic in 1985, is a series of television cameras and sonars that transmit both wide angle and close-up shots of the ocean bottom while maneuvering in the ocean. The JASON is a remotely operated vehicle that can negotiate the seafloor, retrieve samples, and do the basic reconnaissance needed prior to manned exploration. Together, the ARGO/JASON technologies represent a significant improvement in the speed with which oceanographers can explore the deepest parts of the ocean. Also, advancements in fiber optic technology allow four high-quality television images to be transmitted from ARGO/JASON to the surface ship via a 4,000-meter cable.

The curriculum developed for the Jason Project takes advantage of the many educational opportunities provided by such a unique and advanced scientific effort. The science of oceanography is addressed, as well as other topics surrounding such exploration that fall under the physical sciences, biology, history, and geography. In addition, the Jason curriculum includes lessons on the telecommunications technology used to bring the pictures to the students, and the robotics needed to build and operate the ARGO/JASON exploration vehicles. Short lessons in mythology and creative writing connect the myths of Jason and the Argonauts to the current effort.

The Jason Project is a provocative vision of the future of distance learning. To date, most distance learning projects have attempted to replicate as closely as possible the existing classroom model of face-to-face instruction. In this traditional view, transmitting the image and voice of the teacher from a remote location into the classroom is seen as a necessary evil, a second choice. This view assumes that it is always better to interact with students face-to-face, rather than through a limited medium like television. Body language, the dynamism of a great teacher, puzzled faces, boredom—all of these elements of classroom management are perceived as compromised in distance learning.

In projects like Jason, however, the traditional classroom setting is reversed: instead of the teacher coming to the students, the students are electronically transported to a new site where teaching can occur. And rather than the media being a compromise, it now makes possible experiences previously out of the reach of students, and, for that matter, out of the reach of most adults as well. Distance learning technologies "... can be used to approximate experiments or experiences that are too dangerous, expensive or otherwise impractical in real life, such as flight simulation, working with radioactive materials, or a trip to a foreign country."[2] Field trips, a standard academic outreach experience, are transformed in two different ways. First, in experiences like Jason, traditional field trips to the local museum can be greatly enriched by remote explorations of deserts, ocean bottoms, and tropical rainforests. Secondly, electronic field trips beamed directly into schools that have satellite receivers (a possibility being explored for subsequent Jason experiences) can substitute for traditional field trips. This can be especially important to isolated schools where a traditional field trip to locations with significant cultural and museum resources is an expensive and often improbable notion.

The Jason Project seeks to combine the power and reach of the media with the experience of live, see-it-as-it-happens scientific research. Such experiences, built into a valid pedagogical framework, have the potential to broaden and invigorate the educational experience for children.

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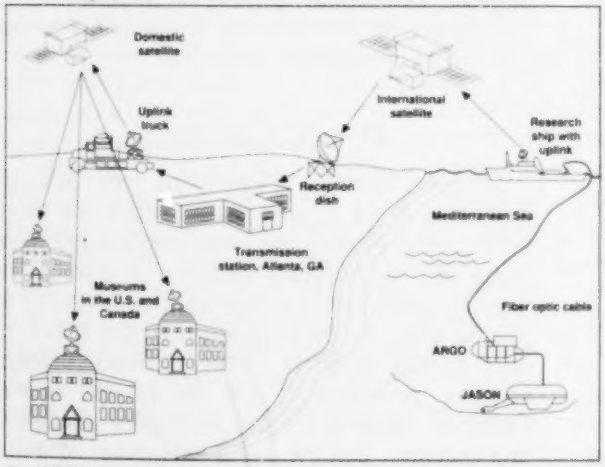
[1] OTA site visit and interviews, May 1989.

[2] Jason Ohler, University of Alaska Southeast, "Distance Education and the Transformation of Schooling: Living and Learning in the Information Age," OTA contractor report, May 1989.

Figure 1-1—The Jason Transmission System



As JASON travels on the seafloor, it sends video images via fiber optic cable to the ARGO control vehicle on to the ship Star Hercules, research base for the expedition. An uplink sends the images and live commentary to an international satellite, which relays them to the broadcasting station in Atlanta, GA for addition of prerecorded sequences. From Atlanta another uplink sends the programming to a domestic satellite, which sends signals to the 12 participating science museums in the United States and Canada, where students watch the whole process delayed only by seconds.

SOURCE: National Science Teachers Association, JASON Curriculum, 1989.

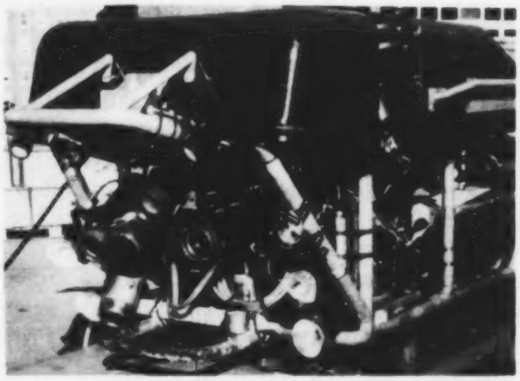


Photo credit: Tom Kleindinst, Woods Hole Oceanographic Institution

Meet JASON, the remotely operated robot vehicle that travels along the seafloor, sending pictures and data to scientists and students sharing in this live undersea exploration.

learning efforts.[12] The Rural Electrification Administration has provided loans for efforts with educational components to rural telephone cooperatives in Minnesota, the Oklahoma Panhandle, and the Papagos Indian reservation, among others. Title III of the Higher Education Act has supported part of the University of Maine's telecommunications network. Another area of Federal activity in distance learning is in training and information dissemination. Distance delivery of training for both civilian and military personnel has been used extensively for a number of years.

Some Federal agencies use distance education in executing their mission, while others fund curriculum development specifically targeted to remote learning environments, or provide technical assistance for planning and development. NASA's involvement with educational telecommunications began with launch of the first communication satellites that were used for education in 1974 and has continued with many activities, including the transmittal of images from vehicles in space, the teacher in space program, and an ongoing videoconference series for teachers.[13] The National Science Foundation (NSF) provided support for science curriculum development on the Jason Project (see box 1-E) and numerous computer network projects. The Department of Education Star Schools projects spend 25 percent of their grants on courses for students and programs for teachers. Several Federal education laboratories provide information that is used by State and local planning groups.

Federal and State telecommunications policies, while promoting more industry competition and choices for schools than in the past, still limit the number and kind of telecommunications services available for distance education. The Federal Communications Commission (FCC) and Cable Act restrictions on the provision of video services by telephone companies, for example, mean that schools may have to bypass the local phone system, the most ubiquitous network in the country, if they want to deliver interactive video telecourses to students.

FCC also controls the availability of telecommunications channels through its licensing of ITFS channels, microwave links, and satellite launching and uplinks. As transponder capacity becomes scarce and channels are used up, pressures for FCC regulation will likely increase. Although the issue of set-asides for education is not new, policies in a deregulated system may need to be rethought.

Telecommunications pricing, unregulated for many transmission systems, is too high for some potential distance learning applications. This is an area that could involve Federal or State assistance, in the form of a special rate for educational telecommunications.

POLICY ISSUES

Distance learning is a growing force in K-12 education in the United States. More and more States are exploring the issue, and several have committed to building systems. A number of districts have also initiated efforts, working to link schools in their locality or reach out to neighboring districts. Many efforts involve schools, government, and the private sector. Distance learning's value to higher education and industry, and the rapid expansion of those efforts, reinforces the continued interest in this educational delivery system. **States, localities, the Federal Government, and the private sector all have roles to play in planning, funding, and implementing distance education. Future development will require involvement of these sectors in four major areas: telecommunications policy; research, evaluation and dissemination; the teacher's role; and the infrastructure for distance learning.**

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[12] In 1988, the program funded nine special nonbroadcast projects at a level of $2.25 million (12.5 percent of the Public Telecommunications Facilities Program budget). These grants include funding for the purchase of equipment for satellite uplinks, three new Instructional Television Fixed Services (ITFS) systems, expansion of two ITFS systems, and a microwave system; grantees include community colleges, universities, a county office of education, and community telecommunications networks.

[13] The National Aeronautics and Space Administration estimates that 20,000 teachers from all 50 States viewed the November 1988 conference on "Living in Space." William D. Nixon, Educational Affairs Division, National Aeronautics and Space Administration, "NASA Distance Learning—Satellite Videoconferencing for Education," unpublished document, May 17, 1989.

Issue 1: Telecommunications Policy

Telecommunications policies can be barriers to implementation or they can expedite development. They require immediate attention at the national level.

Because communication technologies can serve as educational tools, they have always been valued as educational resources.[14] In policy debates over radio spectrum allocation in the 1920s, the value of radio for education was debated, but the Federal Radio Commission gave preference in spectrum allocation to commercial radio providers. The debate over television spectrum found a more organized and aggressive education community, aware of the special needs of education in a limited-resource marketplace.[15] The debate resulted in the Public Broadcasting Act of 1967, which reserved channels for educational television. Since then, the effect of telecommunications policy on education has not been explicitly debated at national levels even though the telecommunications industry has undergone a complete transformation with the advent of new technologies and changing governmental policies and regulations.

In a deregulated telecommunications marketplace, education may be at a disadvantage. However, education could prove to be a significant market, as shown by the variety and number of service providers who have already entered the field. For the promise of distance learning to be realized, the education community must make its requirements and needs known to the telecommunications policymakers, and policymakers must ensure that these needs are considered.

Telecommunications policies affect costs, capacity, and types of services available to distance education. Yet the Federal policy issues in this arena have not been reviewed in light of this fast-growing phenomenon. As Congress confronts telecommunications issues in the 1990s, and sets the direction for the 21st century, it will be critical to review and shape those policies to reflect the Nation's educational needs.

Issue 2: Research, Evaluation, and Dissemination

With the dramatic proliferation of distance learning projects in the last 5 years, many questions regarding effectiveness, methodology, and design have been raised. Many States and local districts plan to implement systems in the next few years. Research on distance learning would be a valuable investment for the Federal Government. Evaluation that explores learner outcomes based on various techniques and technologies is needed by States and schools, as they seek to match the right systems to their specific needs. The Federal Government can, through its traditional function as the funder of research, contribute greatly to the quality and effectiveness of distance education in this country. Also, because the use of distance learning in K-12 education is so new, many working systems still need fine-tuning. This means applying research and calling on the expertise and technical assistance of those with experience. The Federal education laboratories already serve dissemination and technical assistance functions for the States and school districts, and could be well utilized. Many groups, including State agencies, institutions of higher education, and even private industry could serve as focal points for sharing information, perhaps with Federal leadership. Federal programs, such as Star Schools, and agencies, such as NSF or NASA, could convene meetings, working groups, and teleconferences on distance learning for school administrators and teachers.

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[14] U.S. Congress, Office of Technology Assessment, *Critical Connections: Communications for the Future*, OTA-CIT-407 (Washington, DC: U.S. Government Printing Office, in press).

[15] The organization behind the education community's efforts was the Fund for Adult Education, which secured the reservation of stations, the activation of these stations, and the establishment of the Educational and Radio Center. Robert J. Blakely, *To Serve the Public Interest* (Syracuse, NY: Syracuse University Press, 1979), ch. 4.

There are significant educational resources owned by the Federal Government that might apply to distance learning curricula and instructional effectiveness. It is difficult to gauge how much of this material would be applicable to K-12 education, because so little evaluation or transfer is being done. The Department of Education Training Technology Transfer Office authorized in the Omnibus Trade Act of 1988 should generate momentum for this needed effort.

Issue 3: The Teacher's Role

Technologies for learning at a distance, while reaching a small but growing number of teachers today, will clearly affect the teaching force of tomorrow. Some will teach on these systems, others will use them to provide additional resources in their classrooms, and many will receive professional education and training over them. Few will be unaffected.

Given the current focus on improving the Nation's schools, enhancing the quality of the teaching force becomes more than a local concern. Congress is now considering how to help prepare new teachers and encourage more to enter the profession. Funding for teacher preparation institutions could support training in the use of distance learning technologies. Similarly, distance learning technologies can be powerful tools in the continuing professional development of teachers, and could be supported in an effort to upgrade the teacher work force. And, as the technology base in schools and colleges across the country is expanded, the concept of regional or national distance learning programs for teachers, similar to the system now in place for engineers, becomes more feasible. Federal and State support for planning and development could make this a reality.

Although States hold primary responsibility for setting standards for those who teach within their boundaries, distance learning raises issues of concern to the Nation as a whole. As barriers of place are removed, it is possible to think of teachers as national resources. A democratic country demands that every child has access to excellent teachers. Just as television made *Sesame Street* and *Mr. Rogers' Neighborhood* part of everybody's community, today's technologies make it possible for students to learn from teachers across the United States. While not advocating a national curriculum, the Federal Government has supported the development of curricular resources; similarly, there may be ways of making teaching resources available nationally.

If we look at teachers as one of our greatest national resources, barriers of State regulation and control may need to be reconsidered. The National Board for Professional Certification has already taken one step in suggesting that there be national standards for teachers, beyond the minimum licensure requirements of individual States. The Federal Government could play a role in convening States, on a national or regional basis, to assess their common needs and resources. These meetings could take place over distance learning systems. Federal support could also fund demonstrations of alternative entry and certification, compensation, and evaluation approaches for teaching that cross State lines.

Issue 4: The Infrastructure for Distance Learning

Distance learning is a viable, effective educational delivery mechanism to address important student, teacher, and systemwide needs in this time of educational reform. The number of local, State, and multistate efforts already in place or planned suggest that this resource is attractive and accessible. Transmission technologies have proven to be readily connectable; systems that are linked by cable can be connected to others that are linked by fiber, microwave, or satellite. Projects using one technology may face only modest costs to connect to a different technology. The growing infrastructure for distance education is composed of many systems, with varied administrative and technical characteristics.

National leadership could expand distance learning to those communities without resources and extend the reach of installed systems. Two approaches can be taken. The first is to build upon existing programs and structures, allowing the system to grow in response to local and State needs and experiences. This approach would consist of specifying expenditures for distance education in current Federal programs and providing continued support for hardware and software needed to interconnect systems. The Star Schools Program, the Public Telecommunications Facilities Program, the Rural Electrification's telephone loan program, and Chapter 2 funds from the Department of Education all contribute to the distance education infrastructure. The last three programs would have greater impact on distance education if program priorities targeted funds for distance education.

The second approach would be to commit to a set of national goals for distance education and to help with State and regional planning and development. Once goals are set, funds could be made directly available, through a grant program, to actively encourage States and localities to enter the system and expand the infrastructure. This approach would not replace existing systems; it would weave them together more quickly and thoroughly than would occur without national leadership.

Together with planning and funding for development, Federal commitments to teacher preparation and training, research, and dissemination will also affect the speed of implementation and the quality of the national distance learning effort. National leadership could bring in all the players and encourage effective collaboration between the public and private sectors. Most importantly, national leadership could focus investments toward the future, ensuring that today's distance learning efforts carry our educational system into the 21st century.

TI-IN NETWORK

The Learning Channel

ETN

PENNSYLVANIA TELETEACHING PROJECT

Chapter 2

Distance Education in Today's Classroom

KET
The Kentucky Network

HOMEWORK
HOTLINE

Discovery

PBS

ASTS
Oklahoma State University

interAct

NASA
National Aeronautics and Space Administration

PACE
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A range of public and private sources provide distance learning programs and materials to schools today.

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Chapter 2

Distance Education in Today's Classrooms

Distance education can be broadly defined as the transmission of educational or instructional programming to geographically dispersed individuals and groups.[1] This form of instruction has evolved as telecommunications and information technologies have advanced. Correspondence courses, the earliest form of distance education, began in the late 19th century. As early as 1938, educators concerned with the distant learner formed the International Council for Correspondence Education.[2] Instructional television (ITV) was a much-touted distance learning model in the 1960s; although ITV fell far short of early expectations, today's telecourses and educational programs reach many learners in diverse settings.

Today, distance education is flourishing in this country and abroad. Large numbers of students in higher education in the Soviet Union, East Germany, and China are distant learners.[3] Britian's Open University is a long-standing model for comprehensive educational services delivered at a distance.

In the United States, at the adult level, distance education has been embedded for many years in the corporate, military, and university continuing education sectors. The technological spur for the rapid expansion of distance learning efforts in the past 5 to 10 years was the advent of video teleconferencing technologies, which allowed two-way interaction. In 1987, there were over 40 generic delivery systems that provided video conferencing to business, in addition to the many private networks in place. The National Technological University is a network providing about 500 engineering post-graduate courses from 24 major universities to over 100 workplaces.[4]

The widespread adoption of computers in schools and the ability to connect them expanded opportunties for two-way interaction among distant locations. Recent technological advances, including development of fiber optics, have expanded the capabilities for two-way interaction even further.

The more important spur for the growth of distance education in K-12 applications, however, has been the needs of the education community itself. Specific problems led to the trend, especially shortages of fully qualified mathematics, science, and foreign language teachers, increased standards for high school graduation, more stringent admission requirements by colleges, and increased demands for inservice training and professional development. These challenges, combined with opportunities presented by new information technologies, caused educators and policymakers to look beyond traditional approaches and consider distance education.

In this study, distance learning is defined as teaching-learning arrangements in which the teacher and student are separated physically; in these applications, a portion or all of the learning interactions occur in real time. Although distant delivery of information via broadcast, computer data links, and other means also provides important resources for the classroom and valuable tools for learning, they are not the principal focus of this special report. This chapter describes the current picture of K-12 distance education in the United States and examines key issues for planning and future development.

FINDINGS

- **Providing courses for underserved or advanced students is the principal application of distance learning for K-12 education.** An increasing number of efforts, however, include modules and enrichment activities for classroom instruction, and staff development and inservice training for teachers and administrators. Despite the explosive growth of distance learning in K-12 education, access to these resources varies nationwide.

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[1] Ellen D. Wagner, "Instructional Design and Development: Contingency Management for Distance Education," paper presented to The American Symposium on Research in Distance Education, July 24-27, 1988, p. 12. This broadly sketched definition serves as an appropriate departure point for this special report.

[2] In 1982, the International Council for Correspondence Education changed its name to the International Council for Distance Education, in recognition of the variety of media that serve education. Michael G. Moore, Pennsylvania State University, "Effects of Distance Learning: A Summary of the Literature," OTA contractor report, May 1989.

[3] In China, almost 50 percent of postsecondary students use distance learning; in the Soviet Union, 30 percent; in East Germany, 25 percent. Ibid., p. 7.

[4] Ibid., pp. 2-3.

- **Distance education has brought new providers into the education field.** Business and higher education, two groups with long track records using distance learning, are now providing educational programming and services to the K-12 market. Schools are learning from the experiences of other distance education users, engaging in innovative partnerships, and choosing from a range of technical and programming alternatives.
- New coalitions across State and district boundaries, new networks of educators, and geographically dispersed schools receiving programming from common providers exemplify changing relationships in the education community. Educators involved in interactive instruction, computer networking, and instructional television, although developing separately, are coming together. **Connections now being established across geographic, instructional, and institutional boundaries provide opportunities for collaboration and resource sharing among many groups for the coming years.**
- Telecommunications and information technologies are increasingly flexible tools, providing links to other resources for problem solving, communication, and manipulation of data, and enabling students and teachers to expand educational horizons. **There is no single best model of distance learning.** The quality and effectiveness of distance learning are determined by instructional design and technique, the selection of appropriate technologies, and the quality of interaction afforded to learners.
- Most K-12 distance learning activities for students are video-based. **However, there are many technological options for delivering education over a distance, and the ability of the teacher and students to see each other may not be a necessary condition for effective distance learning.** Models of teaching strategies based on computer applications, for example, are emerging that may be equal to or more effective than video-based instruction or traditional instruction. **Further research and experimentation with innovative teaching strategies and technologies is needed.**
- Distance learning has proven effective in adult learning and training settings. This suggests that distance learning can be effective in the elementary and secondary schools, but research in K-12 applications is limited. **However, existing research, project evaluations, and anecdotal evidence strongly suggest that distance education is an effective means for delivering instruction and educational resources to students and teachers.**
- **Telecommunications systems that serve education can also benefit the community at large, and vice versa.** New uses include the application of information and educational resources for K-12 students, adults, senior citizens, local government and organizations, and business. **In rural areas especially, telecommunications systems and services are tied increasingly to economic development and community survival.**

SNAPSHOTS OF DISTANCE LEARNING

The picture we have of distance education in today's classrooms is at best a series of snapshots. This is because efforts are new and continually changing. The snapshots in this report are based on the OTA 1988 survey of State technology activities,[5] other information provided by the National Governors' Association and the Council of the Chief State School Officers, seven case studies of distance learning,[6] and OTA site visits and participation in various conferences on distance learning. Additional information on various projects was provided by program offices in several Federal agencies, and by a number of State education agencies.[7] Finally, OTA was contacted by various projects across the country who shared information on their efforts.

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[5] This survey was conducted as part of OTA's assessment on educational technology in elementary and secondary education. See U.S. Congress, Office of Technology Assessment, *Power On! New Tools for Teaching and Learning*, OTA-SET-379 (Washington, DC: U.S. Government Printing Office, September 1988).

[6] Bruce Barker, Texas Tech University, "Distance Learning Case Studies," OTA contractor report, May 1989.

There are several clear trends. **Distance learning is expanding.** Until recently, few States or districts had either projects or plans for distance education at the K-12 level. Fewer than 10 States were investing in distance learning in 1987; 1 year later two-thirds of the States reported involvement.[8] Today, virtually all States have an interest or effort in distance education.[9] Within States, a growing number of efforts involve local districts, regional education service centers, nearby universities, and community colleges. Student enrollment in distance education courses provided on a local, regional, or national basis has increased. (See table 2-1.) While a national survey of representative school districts indicated that an estimated 22 percent of school districts now use distance learning, some 33 percent expect to be using these resources by 1990.[10]

The second trend is more subtle. **Distance learning is changing educational boundaries—boundaries traditionally defined by location and by institution.** In the pooling of students and teachers, distance learning efforts reconfigure the "classroom." No longer bound by the physical space, classrooms extend to other students in the same district, to other districts, to other States, or even across national borders. When this happens, institutional arrangements necessarily change. Thus, a high school course in German may be taught by the local high school teacher, the German teacher four districts away, or a university professor.

The assortment of educational providers, institutional arrangements, academic subjects, and technologies is striking. Boxes throughout this report illuminate this diversity of efforts and interests. The balance of the chapter shows more snapshots, and highlights many characteristics of current distance education efforts.

Table 2-1—Growth in Selected Distance Learning Projects Between 1983-89

Minnesota Distance Learning Projects	
Earliest operating projects: 1983	
Number of projects:	1983-84—1
	1988-89—17
Number of courses:	1983-84—less than 10 courses offered
	1988-89—139 courses offered
Number of students:	1983-84—information not available
	1988-89—3,869 students
Number of sites:	1983-84—4 districts
	1988-89—107 districts
Arts and Sciences Teleconferencing Service (ASTS)	
Year begun:	1984; pilot program offered in fall of 1985
Number of courses:	1985-86—1 course offered
	1988-89—7 courses offered
Number of students:	1985-86—333 students
	1988-89—2,500 students
Number of sites:	1985-86—50 districts in 2 States
	1988-89—236 districts in 19 States
Staff development:	1985-86—video teaching workshops offered
	1988-89—8 programs, each 2.5 hours
TI-IN Network	
Year begun:	1985
Number of courses:	1985-86—14 courses offered
	1988-89—25 courses offered
Number of students:	1985-86—350 students
	1988-89—4,000 students
Number of sites:	1985-86—50 schools in 3 States
	1988-89—780 schools in 32 States
Staff development:	1986-87—offered 400 hours of programming yearly
	1988-89—offered 400 hours of programming yearly
Satellite Telecommunications Educational Programming (STEP) network	
Year begun:	1986
Number of courses:	1986-87—5 courses offered
	1988-89—5 courses offered
Number of students:	1986-87—230 students
	1988-89—855 students
Number of sites:	1986-87—13 school districts in 1 State
	1988-89—58 school districts in 8 States
Staff development:	1988-89—offered 20 different programs
	1986-87—offered 2 different programs

SOURCE: Office of Technology Assessment, 1989, from data provided by the projects listed above.

Where Has Distance Learning Taken Hold?

Impetus for K-12 distance learning has come primarily from the Nation's rural schools. Shifting economic and demographic patterns have left many small and rural schools with declining student populations and even more limited financial and instructional resources. At the same time, States have increased requirements for curriculum, graduation, and teacher training, and colleges and universities have toughened entrance requirements. Solutions such as school consolidation or transporting students or teachers have often been stretched to their geographic limits; these approaches are also disruptive and politically unpopular. The local school is the heart of the community in most rural areas. If the community is to thrive and grow, so too must the school. Increasingly, small rural schools have turned to distance learning as a way of keeping their local character while still offering students a range of educational resources. (See chapter 5, box 5-C.)

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[7] Some States have completed extensive surveys and assessments of distance learning activities in K-12 education; others have also prepared the groundwork for either statewide or regional efforts that will begin in the near future. See for example, Office of the Superintendent of Public Instruction, *Report to the Legislature on Linking for Learning: K-12 Educational Telecommunications Plan* (Olympia, WA: December 1988); Michigan State Board of Education, *Inventory of Instructional Telecommunications Systems in Michigan* (Lansing, MI: March 1989); and Texas Education Agency, *1988-2000 Long-Range Plan for Technology* (Austin, TX: December 1988).

[8] National Governors' Association, *Results in Education: 1988* (Washington, DC: 1988).

[9] See ch. 5. See also State and local activities profiled in app. A.

[10] Jeanne Hayes, Quality Education Data, Inc., personal communication, August 1989, from data collected in the QED 1989-90 Technology Trends Survey. Quality Education Data, Inc., *Microcomputer and Video Purchasing and Usage Plans: 1989-90 School Year* (Denver, CO: 1989).

Mismatches between student needs and qualified teachers are not limited to rural schools. Large urban school districts also face problems hiring qualified teachers in fields such as English as a second language, special education, and advanced mathematics and science. In addition, urban districts also face problems regarding parental involvement, cultural relations, and staff development and training. Suburban and urban districts are beginning to look to distance learning to meet some of these needs. **Distance learning, once perceived as a resource for the geographically isolated school, is becoming a solution for overcoming other educational deficiencies.**

Who Is Being Served?

Grades 9 to 12

Many students served by video-based distance learning today are high school students taking courses to fill graduation or college entrance requirements that their schools cannot provide on site. Many schools cannot afford to hire teachers for calculus or French if only five or six students will take the class; other schools cannot convince teachers qualified in these subjects to live in their part of the country.

Gifted and Talented Students—A large porti of the secondary school students receiving distan instruction today are academically gifted and t ented students—those whom teachers feel c "handle" the unique circumstances of being taug by a teacher outside the classroom. These studen are likely to be more self-motivated, and thus m not even need to have an adult in the classroom keep them on task. It has been assumed (althoug empirical evidence is sparse) that distance learnin courses typically require more mature and motivate students in order to be effective.[11] Interaction wi the teacher is changed, and more responsibility placed on the learner. Those not committed may fin it difficult to keep up.

Underserved and Disadvantaged Students—Th Federal Star Schools Program requires that at lea 50 percent of funding for projects serve educationally disadvantaged students and schools. Thi commitment has spurred the growing trend fo distance learning systems to reach these populations. Some States receive an interactive distanc learning curriculum through the Star Schools Program. (See box 2-A.) Other systems have long ha as a goal providing instruction to culturally isolate or economically disadvantaged populations. Activities supported by the Bureau of Indian Affairs (BIA and by the State of Alaska, for example, reac underserved populations on Native American reservations and in remote Native Alaskan villages respectively. Although few homebound and physically handicapped students currently have access they are ideal candidates for interactive distanc education. Telecommunications learning opportunities could be extended to other groups of learner who, for a variety of reasons, are educationally disadvantaged or culturally or physically isolated.[12]

Grades K to 8

Very young students have also begun to benefit from distance learning technologies. In the lower grades, classroom teachers often use enrichment materials provided via telecommunications. Public television stations have been offering instructional

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[11] See the section, "Is Distance Learning Effective?" later in this chapter. Because distance learning has been used so effectively with adult learners, and is only now being tested with learners who may not be self-motivated, many people assume that such maturity is necessary for a student if distance learning is to succeed. Little hard evidence for this conclusion exists; it is possible that as distance learning is applied more to at-risk students, and instructional design is improved to overcome the barriers of geography or culture inherent in the process, such instructional methods could be even more beneficial for students who do not meet the characteristics of the adult learner. See A.W. Bates, "Television, Learning and Distance Education," *Journal of Educational Technology*, vol. 14, No. 3, 1988, pp. 213-225.

[12] For discussion of the various kinds of isolation that distance learning can overcome, see Jason Ohler, University of Alaska Southeast, "Distance Education and the Transformation of Schooling: Living and Learning in the Information Age," OTA contractor report, May 1989.

Box 2-A—The Star Schools Program in Mississippi

Significant Federal resources, as well as some State and local resources, are flowing into Mississippi for distance learning. Three of the four projects funded under the Federal Star Schools Program serve Mississippi. Two universities, the State education agency, and the State educational television network are partners in the Star Schools consortia. A total of 112 schools in the State will be served by the Star Schools grantees (Midlands Consortium, TI-IN United Star Network, and Satellite Educational Resources Consortium—SERC) in 1989-90; another 50 schools will be added using second-year Star Schools funding. This interest in Mississippi is due, in part, to the requirements of the Star Schools legislation that at least 50 percent of the funds serve Chapter 1-eligible school districts and the educationally underserved. All of Mississippi's 152 school districts are Chapter 1-eligible.

The Midlands Consortium, through its Mississippi partner, the University of Mississippi, is concentrating efforts in three areas: placing satellite downlinks and associated equipment in schools, training school personnel in the use of the technology, and conducting research and evaluation. Sixty-five schools received downlinks through the Consortium and 100 teacher/facilitators from these schools participated in training workshops in July 1989. Three research projects on satellite-based distance education are in progress.[1]

One of the partners in the TI-IN Network, Mississippi State University, is producing teacher inservice courses in mathematics and science, taking advantage of the university's noted strength in science and engineering. In addition, Mississippi teachers will be able to take courses or institutes in teaching junior high science, Earth sciences, theory of equations, and physics that will be offered throughout the nationwide TI-IN Network during the 1989-90 school year. The Star Schools TI-IN funding also supported the installation of 33 satellite downlinks at schools in the State; another 25 schools will receive equipment through the second-year grant.

SERC partners include the Mississippi State Department of Education and the Mississippi Authority for Educational Television. SERC has placed satellite downlinks in 14 schools in Mississippi. SERC offered courses to selected schools in the 1988-89 school year as a pilot test, and will offer expanded classes and staff development in 1989-90.

Another factor in the Mississippi picture is the aggressive educational reform effort under way in the State. Major components of that effort include full-day, statewide kindergarten, teacher aids for K-3 classes, and new procedures for school accreditation, teacher certification, staff development, and teacher evaluation.[2] Governor Ray Mabus is expected to announce another package of educational reforms including a proposal for a statewide Instructional Television Fixed Service system.

The State Department of Education plans to evaluate distance learning outcomes. If proven effective, distance delivery of classes may affect key elements of the State reform efforts. For example, the State has emphasized raising standards for schools through performance-based accreditation reviews. This has created pressures to close many small high schools that are unable to offer the full range of courses required by State reforms. If distance delivery of classes proves effective, consolidation may not be needed.

The State Superintendent of Education's office and the Star Schools grantees solicited written commitments for the term of the grants from all the local school boards with distance learning sites. Local commitment is crucial for ensuring the survival of these projects. However, it is unclear whether all the Star School sites will be able to fund distance learning once the Federal subsidies disappear.[3]

One of the primary objectives of the Star Schools legislation was to serve disadvantaged students like those in Mississippi. Mississippi's experience with Star Schools may demonstrate interactive distance learning's capacity to offer important educational opportunities to students from resource-poor homes and communities. It will be important to follow the progress of these three different efforts, and to study the dynamics of Federal investments in distance learning in a State with both a commitment to educational reform and significant educational deficiencies.

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[1] Robert A. Young, director, Office of Distance Learning, University of Mississippi, testimony before the Senate Subcommittee on Education, Arts, and Humanities of the Committee on Labor and Human Resources, Apr. 27, 1989.

[2] Olon E. Ray, Special Assistant to the Governor, testimony before the Senate Subcommittee on Education, Arts, and Humanities of the Committee on Labor and Human Resources, Apr. 27, 1989.

[3] Pat Teske, Office of the State Superintendent of Education, Mississippi Department of Education, personal communication, August 1989.

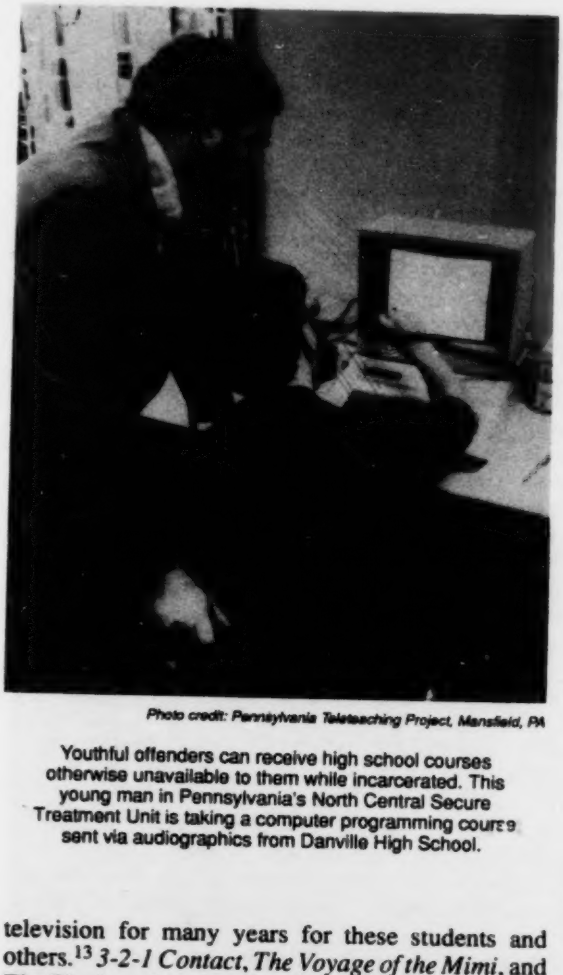

Photo credit: Pennsylvania Teleteaching Project, Mansfield, PA

Youthful offenders can receive high school courses otherwise unavailable to them while incarcerated. This young man in Pennsylvania's North Central Secure Treatment Unit is taking a computer programming course sent via audiographics from Danville High School.

television for many years for these students and others.[13] *3-2-1 Contact*, *The Voyage of the Mimi*, and *The Big A* are just three of the many products for the K-8 audience broadcast or delivered by satellite by Public Broadcasting Service (PBS)-member stations. Some providers offer special events such as the Jason Project (see chapter 1, box 1-C), and continuing video seminars by working scientists who meet with students through the Talcott Mountain Science Center program, *On the Shoulders of Giants*. More and more activities are being directed to these students.

Educators

In addition to student needs, local school districts and States recognize the role of distance learning technologies for staff development programs and teacher inservice training. Often, teachers and administrators must travel hundreds of miles in order to attend classes, seminars, and workshops. The time, effort, and expense of travel limit opportunities for professional interaction. Just as distance learning offers a way to bring information, enrichment, and instruction to students, so can the needs of educators be served. In addition to video teleconferences, computer networks and computer conferencing give teachers and administrators a way to communicate with colleagues and obtain course materials. One of the largest of these is the Ag Ed Network, an agricultural database service that links schools in 18 States, and gives teachers access to more than 1,200 lessons and projects. Teachers using this service reach over 28,000 vocational-agricultural students in all 50 States.[14] Teachers in BIA schools receive staff development programming through the Eastern Navajo Agency Network.[15]

Many of the multistate video-based providers have extended their inservice training and staff development offerings dramatically in recent years. (See again table 2-1.) The effectiveness research on distance learning has concentrated on adult learners and training activities, and has shown that distance-delivered education is usually as effective as face-to-face instruction. Teachers and school personnel are well suited to distance learning. (Chapter 4 discusses in greater detail the uses of distance learning by and for teachers.)

Community Members

Telecommunications systems that link elementary and secondary schools during the day can serve other community members in the evenings and on weekends. Other communities of learners are reached through systems and programming provided by or through universities and other educational institutions (e.g., museums, libraries, and community centers). In rural communities, especially, the development of advanced telecommunications and information systems for both education and economic development are helping rural areas remain competitive with their more information-rich urban counterparts.

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[13] The Public Broadcasting Service (PBS) and their member stations have been providing instructional programming for all grades since PBS' founding in 1969.

[14] "Online Database Aid to Vo-Ag Education," *T.H.E. Journal*, vol. 16, No. 5, December/January 1988/1989, p. 38.

[15] The network is operated by the University of New Mexico's Center for Technology and Education under a contract with the Bureau of Indian Affairs. Paul Resta, director, Center for Technology and Education, University of New Mexico, personal communication, August 1989.

Kirkwood Community College in Iowa, besides providing high school and college credit courses, offers continuing education classes 2 evenings per week, and training for business and industry. Programming is determined by a local business advisory committee. The Kirkwood network has also been used for community service programs, such as updates by area legislators on State and Federal legislative issues, and information on crop diversification and financial planning for farmers.[16]

Some school districts and States have joined resources with universities, government bodies, and others when planning systems to share start-up and installation costs. Maine is installing a two-way video-based community college system utilizing the State universities, extension sites, and all the State high schools.[17] Programming will originate from university sites for secondary, undergraduate, continuing, and vocational education; learners will be able to use the various downlink sites for multiple types of course offerings. (See chapter 5, box 5-A.)

What Is Being Delivered?

Whole Courses

The primary use of video-based distance learning technologies has been to provide courses not available to schools due to geographic isolation or other limitations. Most of the need is in foreign languages, mathematics and science, and humanities; table 2-2 lists some of the most frequently offered courses.[18]

Many classes and enrichment activities are videotaped, even if the students view the sessions live. The opportunity to review complicated material and ask further questions has proven valuable. The videocassette recorder (VCR) is a familiar technology to most teachers and is widely used in the classroom. Although not part of the interactive environment per se, the VCR is a critical and ubiquitous element of technology in the classroom.[19]

Partial Course Materials

Students also receive "modules" or "units" that are integrated into the curriculum. For example, distance learning modules supported under the Technical Education Research Centers (TERC) Star Schools project encourage students to collect and analyze scientific data, and compare it with that gathered by students across the country. Topics include the study of radon, acid rain, and weather. The Jason Project developed mathematics, science, and social science curriculum for grades 4 to 12 to accompany the live exploration of the Mediterranean sea bottom. Partial course delivery is a promising area for innovation in distance learning. Reforms in science and mathematics education, particularly, call for more experiences for students with hands-on activities and cooperative learning; distance education may grow to meet these challenges.

Enrichment Materials

More and more students receive enrichment activities delivered by distance education technologies. These activities are generally one-time-only presentations designed to inform students (and teachers) on a particular topic. Some are live and interactive, although many schools tape such materials to use at their convenience. In 1989, the Satellite Educational Resources Consortium (SERC) offered six science, technology and society seminars to over 18,000 high school students. Public television stations and independent producers generate a large body of programs that are used as enrichment materials. The Telelearning Project takes its students on "electronic field trips," telephone conference calls to outside authorities, or other classrooms. (See chapter 1, box 1-B.)

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[16] Rich Gross, dean of Telecommunications, Kirkwood Community College, "The Impact of Educational Telecommunications—Some Observations," unpublished document, May 1989, pp. 3-4.

[17] University of Maine at Augusta, *Community College of Maine Newsletter*, vol. 1, No. 1, March 1989.

[18] The emphasis noted in table 2-2 is reinforced by a survey of representative districts conducted by Quality Education Data. In QED's survey of what whole courses were being offered in video-based distance learning systems, foreign language courses ranked first, followed by mathematics, social studies, computer sciences, and science. When QED's more detailed categories are combined to match table 2-2's breakdown, the figures are very comparable. Quality Education Data, op. cit., footnote 10.

[19] Quality Education Data reports that there are 191,000 VCRs in elementary and secondary schools in the United States, or 2.4 per school. Quality Education Data, Inc., *1989-90 Catalog of Educational Mailing Lists and Marketing Services* (Denver, CO: 1989).

Table 2-2—Whole Courses Offered in the United States in 1988-89 by Selected Distance Learning Projects[a]

Foreign languages (119)[b]	Mathematics and science (110)	Humanities (69)	Political science and history (19)	Business and economics (16)	Vocational education (9)	Social studies (8)
Spanish (38)	Calculus (17)	English (28)	History (11)	Accounting (8)	Shorthand (7)	Social studies (4)
French (26)	Mathematics (12)	Art/art history (7)	Law (5)	Economics (7)	Electronics (1)	Geography (2)
German (26)	Psychology/ sociology (12)	Composition (7)	Government/ politics (3)	Sales/marketing (1)	Home economics (1)	American studies (1)
Latin (12)	Science (11)	Literature (7)				Chinese culture (1)
Japanese (5)	Physics (9)	Communications (4)				
Greek (4)	Computers (6)	Humanities (4)				
Russian (4)	Trigonometry (6)	Education (3)				
Chinese (3)	Algebra (5)	Journalism/media (3)				
Italian (1)	Astronomy (4)	Theater arts (3)				
	Pre-calculus (4)	Music (2)				
	Statistics (4)	Philosophy (1)				
	Chemistry (3)					
	Health (3)					
	Technology (3)					
	Geology (2)					
	Anatomy (1)					
	Biology (1)					
	Biomedics (1)					
	Anthropology (1)					
	Elementary analysis (1)					
	Entomology (1)					
	Fish and wildlife (1)					
	Marine science (1)					
	Physical science (1)					

[a] This table represents the total number of courses offered in the subject listed in the distance learning projects in Appendix A. Note that these classes are not of equal size; each class could have from 12 to 1,200 students in it.

[b] Numbers that appear in parenthesis represent the total number of courses offered under a general subject heading.

SOURCE: Office of Technology Assessment, 1989.

Training and Staff Development

Teachers and educators are using distance learning systems installed in their schools and districts for seminars, college-level courses, workshops, and certification classes. Some school districts have made administrative and professional interaction the primary focus of their systems. The Los Angeles Educational Telecommunications Network (ETN), run by the Los Angeles County Office of Education, broadcasts exclusively staff development activities via satellite to most county schools. ETN has been a leader in statewide staff development efforts, which are critical to the curriculum reform effort in California. (See chapter 4, box 4-C.) Although few of the video-based systems are installed primarily to serve teachers and staff, almost all quickly see the utility of this technology for professional development. All the large providers have extensive offerings in staff development and inservice training.

Student and Professional Communications

Students and teachers using telecommunications technology can also reach outside information, people, and resources on their own. Students tap into databases, use homework hotlines, and participate in electronic conferencing with their peers. More than 6,000 schools have the modems necessary to communicate using computers.[20] AT&T's Long Distance Learning Network, in pilot projects, connects students in grades 3 to 12 in "Learning Circles," where they can discuss and learn about specific topics such as food, writing, and culture. The main thrust is to encourage students to work cooperatively on specific projects in key curriculum areas.[21] Many other projects expand the opportunities for student communications with their peers. Videoconferencing and computer networking linked students from different countries in the Kids Interactive Telecommunications Project by Satellite. (See box 2-B.)

Teachers are using computer networks to increase professional contact with their peers, exchange curriculum materials and classroom ideas, and access databases and information sources. Science teachers in New Jersey are using telecommunications to share resources and support. Teachers attend workshops every 6 weeks, and between workshops they use electronic mail and computer conferences to share curricular ideas and self-developed materials such as laboratory exercises and activity sheets.[22]

How Are Educational Materials Being Delivered?

The primary use of the distance learning technologies available today has been to replicate the experience of face-to-face instruction. The characteristics of traditional instruction retained are instruction in the present (live), and teacher-student and student-student exchange (interaction). These qualities distinguish this application of educational technology from previous attempts, particularly educational television, where interactivity was virtually impossible.

Live experiences can heighten the interest of many students and sharpen the classroom activity by demanding that teacher and student be ready when programming begins. This demand of timeliness can also work as a disadvantage; for example, school districts' bell schedules often conflict. For programming across districts, this can be a significant sticking point.

Live With Interaction

Interacting with the teleteacher is the key ingredient in recreating the traditional instructional model. Whether live or delayed, interaction with the instructor is considered by many as a necessary condition for successful distance education.[23] In many of today's systems, interactivity between teacher and students is accomplished via telephone. The video image of the teacher is seen in the classroom, but the teacher cannot see the students in the respective classrooms; this arrangement is known as one-way video and two-way audio. Many of the larger

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[20] OTA, op. cit., footnote 5, p. 192. It is unclear, however, how many of these modems are being used by students or for uses other than the administrative communication of data.

[21] Margaret Riel, "Cooperative Learning Across Classrooms in Electronic Learning Circles," paper presented at the American Educational Research Association Annual Meeting, San Francisco, CA, Mar. 27-31, 1989.

[22] Howard Kimmel et al., "Computerized Collaboration: Taking Teachers Out of Isolation," *Computing Teacher*, November 1987, vol. 15, No. 3, pp. 36-38.

[23] See, for example, the OTA case studies of distance learning in Barker, op. cit., footnote 6. See also Wagner, op. cit., footnote 1; Bennett H. Berman, International Center for Information Technologies, Washington, DC, "Matching the Distance Learning Medium to the Message"; and Desmond Keegan, Kensington Park College, Adelaide, Australia, "A Theory for Distance Education From Peters to Peters," papers presented at the American Symposium on Research in Distance Education, Pennsylvania State University, July 24-27, 1988.

Box 2-B—Kids Interactive Telecommunications Project by Satellite

The 1986 Chernobyl nuclear accident may have been just a story on the news for American students, but fo European young people living downwind of the disaster, it was a terrifying reality that meant contaminated field and poisoned food. Many of these students remain skeptical about nuclear power. This is one of the lesso American eighth grade students learned when they talked live via satellite with students in Karlsruhe, We Germany. Thanks to a unique consortium involving public secondary schools, higher education, and privat industry, on June 1, 1989 students from three Massachusetts middle schools met with their West German peers t discuss nuclear power, toxic waste disposal, alternative energy sources, rock and roll, and other global issues.

The 90-minute teleconference was the product of months of work and cooperation between the America schools, the University of Lowell, the Massachusetts Corporation for Educational Telecommunications (MCET), Massachusetts Educational Television, German educators, and the Digital Equipment Corp. (DEC). Together the formed a cooperative international telecommunications partnership, the Kids Interactive Telecommunication Project by Satellite (KITES).

KITES was launched by a professor at the University of Lowell. Through MCET he approached the manag of DEC's corporate video network with a proposal: "Why not use installed corporate telecommunications capacit to help kids explore important curricular content in a cross-cultural setting?"[1] DEC agreed to make available i two-way international network. DEC also loaned VT100 terminals and computers to the students and teachers i Lowell, Dracut, and Chelmsford schools, and to one of the German teachers, so they could communica electronically throughout the school year prior to the broadcast.

Staff from the University of Lowell's College of Education worked with local teachers to develop curricul and to offer training in the use of two-way television. To prepare for the international videoconference, KITES sponsored bi-weekly environmental science classes on the University's Instructional Network, a fully interactiv two-way television facility that connects schools in seven towns to the four university campuses. The students wro to their German peers. The American schools also took field trips to each of the other schools. Project staff foun that the cultural stereotypes between the inner city, suburban, and rural schools were just as large as the stereotyp between American and West German students.[2]

The path from project startup to the June 1 teleconference was not a smooth one. The most serious proble centered on the lack of resources for curriculum development and training. Although the in-kind value of DEC's contribution, combined with personnel time from the university and other participating organizations, exceede $100,000, there were virtually no funds for teacher release time, materials, or consultant help. Support of this typ is critical for long-term success.

When the day of the teleconference finally came, the serious moments were balanced with light ones. Studen on both sides of the Atlantic started off a bit nervously, but quickly relaxed when the American side played a ra video, complete with a grafitti-ridden school yard setting and break dancing. The German group then played a video of their school's rock band, while the American host, a local television meteorologist, danced with a student to the universal language of rock. But serious discussion of issues dominated the teleconference, and the students' preparation on the topics of energy and the environment was evident in their questions to one another. Students learned that pollution problems are similar in both countries, citing too many cars and airplanes, not enough recycling, and pesticides as common problems. Still, when they took a straw vote for or against nuclear energy, the American students voted about 90 percent in favor; the German majority voted against, reflecting Chernobyl's impact.

Future videoconferences will explore other curriculum-related themes, expand the number of participating school sites through Massachusetts Educational Television facilities, and involve museums, libraries, and community centers as well. KITES also hopes to create links with other Western European, Asian, Eastern Block, and Third World nations. KITES's goal is to give students the tools and knowledge they need to communicate in the global community that they will inherit.

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[1] John LeBaron, coordinator and associate professor, Kids Interactive Telecommunications Project by Satellite, University of Lowell, MA, personal communication, July 1989.

[2] David Singer, "American and W. German Students Trade Ideas Live," *Minuteman*, Bedford, MA, June 8, 1989, p. 9.

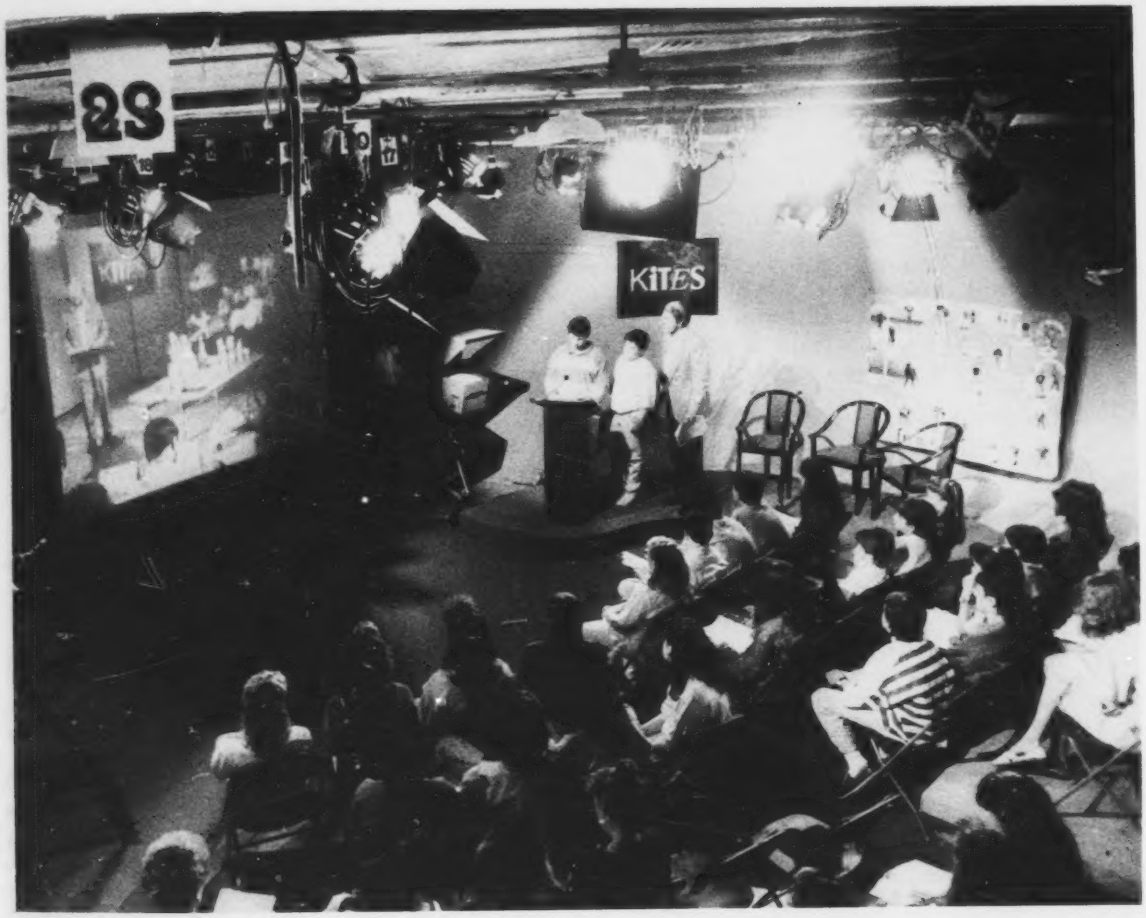

Photo credit: Hillary Levine, Beacon Communications Corp., Acton MA.

Massachusetts students gather at Digital Equipment Corp.'s television studios to discuss global issues with their counterparts in Germany.

video-based providers are using this model, including Satellite Telecommunications Educational Programming (STEP), Oklahoma State University, and SERC.

Other systems add two-way video or graphics interactivity to the almost universal two-way audio. The Pennsylvania Teleteaching Project uses two-way computer hookups along with two-way audio to student-teach classes in North Dakota and other States. This audiographics system is a less expensive alternative to video-based distance learning, which allows the teacher and student to converse through the computer keyboards as well as on the telephone line.

Two-way video, found usually in small, multidistrict systems, is the closest imitation of the traditional classroom that present technology allows. The Shar-Ed Video Network, linking four school districts in the Oklahoma Panhandle, is one example. (See box 2-C.) Minnesota has a number of systems

Box 2-C—Panhandle Shar-Ed Video Network

The Oklahoma Panhandle, a remote, sparsely populated area that inspired John Steinbeck's novel, *The Grape of Wrath*, seems an unlikely site for a two-way, full-motion, state-of-the-art fiber optic television network. Nevertheless, this area, once described as "no man's land," illustrates how distance learning technologies can assi those schools most in need of resources, through cooperative efforts of local businesses and schools. The system allows districts to share teachers electronically and expand high school credit course offerings, provide inservice training to teachers, hold administrative meetings, and provide community education programs for local residents.

Located in the eastern end of the Panhandle, Beaver County includes four school districts that serve students spread over long distances. The Beaver School District has 519 K-12 students coming from a 426-square-mile area; Forgan has 191 students across 397 square-miles; Balko has 159 students across 305 square-miles; and Turpin has 420 students within a 303-square-mile area. The educational problems faced by Beaver County schools are typical of small, isolated school districts. It is almost impossible to offer advanced courses and specialized subjects on a regular basis. In the past, these kinds of courses, if offered at all, were provided in alternate years. In addition, low student enrollment made it prohibitively expensive for each school to employ a full-time certified instructor, even if one could be found. Attempts to fill the need with "circuit riding" or traveling teachers were not succeeding. Yet because of increased high school graduation requirements, higher college entrance requirements, demands for courses for gifted students, and needs to improve staff development, the superintendents agreed that new solutions were necessary. As the Forgan school superintendent explained: "Each of the districts in the area has a limited number of teachers and a rather restrictive curricula, and not enough State monies to rectify either of these two shortcomings. We had to look for new alternatives and for outside funding to help us."[1]

Four years ago, Beaver County superintendents and school board members learned about distance learning projects in Wisconsin and Minnesota. They visited projects and hired consultants to analyze site and technical requirements, examine alternatives, and plan the system. The four districts, with support from the State Director of Rural Education, agreed to seek external funding for a two-way full-motion interactive television system for sharing instruction among their schools. They established the Panhandle Shar-Ed Video Network Cooperative, a partnership between the four school districts and Panhandle Telecommunications Systems, Inc., a subsidiary of Panhandle Telephone Cooperative Inc. (PTCI). PTCI is a co-op owned by 4,200 individuals in the three-county Panhandle region. According to Ron Strecker of PTCI, the Network is an important factor in keeping the schools open and in assuring the economic viability of the region.

> These schools provide education to the children of our members. If any of the schools closed, we knew that PTCI would realize a loss in additional customers. So it was in our best interest to see that this did not occur. If any of the schools were to close then our communities would die. We wanted to keep these communities alive and this factor helped expedite our desire to participate in a joint project.[2]

To build their distance learning system, the four superintendents sought outside funding. Grants from the Oklahoma Board of Education, the State legislature, and the Oklahoma Department of Education (Office of Rural Education) totaled $190,000. Two Oklahoma foundations contributed $75,000 each. These funds ($340,000) covered startup costs: installation of four-strand and eight-strand fiber optic cable between the four schools, the telecommunications hookups, and studio classroom equipment (cameras, television monitors, microphones, VCRs, and facsimile machines). They also covered costs of a 5-year lease of the fiber optic lines that are owned and operated by PTCI. Districts covered other remodeling costs, including the installation of observation booths so that students and teachers would not be disturbed by the onslaught of visitors expected.

(Continued on next page.)

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[1] Doug Rundle, superintendent, Forgan School District, personal communication, in Bruce Barker, Texas Tech University, "Distance Learning Case Studies," OTA contractor report, June 1989.

[2] Ron Strecker, administrator, Panhandle Telephone Cooperative, Inc., personal communication, in Barker, op. cit., footnote 1.

that serve four to seven districts each with two-way video and audio. The capability to transmit signals from any of the sites in the system makes it possible to originate programming from any local site. In many of the Minnesota projects this is the case; each of the schools offers one class a day to students throughout the system.

Live With Limited or No Interaction

Materials that are broadcast or transmitted live, predominantly instructional programs on public television stations, are often recorded by teachers or schools for previewing before use in the classroom. Public broadcasting stations are a ubiquitous, expe-

In its first year (1988-89), the Shar-Ed Network offered four courses among the schools: Art History, Spanish, Advanced Placement English, and Accounting II (see figure 2-1). While many miles apart, classes operated as if students were side by side: the teacher and students in all sites could see and hear each other simultaneously. No class exceeded a total of 20 students, and each receiving class had a classroom facilitator appointed by the principal who served as proctor. Television teachers were given one additional preparation period. A 5-percent salary bonus is under consideration. Administrators, teachers, and students have been very positive about distance learning. Student achievement in courses has been high, and there have been other benefits as well.

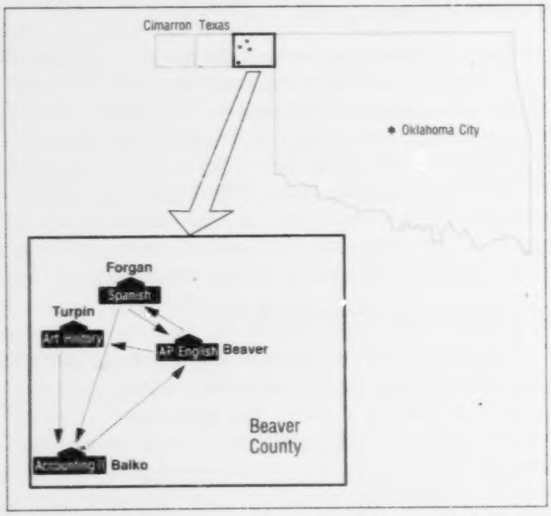
Three years in the making, the Shar-Ed Network offers a way to expand resources for the districts yet maintain local control of curriculum, assure high-quality instruction, and keep the local school/community identity intact. The greatest tribute to the cooperative approach to the project is the fact that the four school districts have agreed on a common bell schedule to alleviate scheduling problems for the interactive video classses.

Future plans call for expanding the network to link the other eight school districts in the Panhandle and to connect Panhandle State University. With the addition of the university, college credit courses and other educational services will be offered for students, teachers, and members of the community.

rienced source of instructional materials for K-12 classes.

Some of the distance learning systems have large classes or limited time for questions, which results in limited interactivity between students and teacher during the class time. Many of these providers offer "office hours" when students can call for help, or tutor time with the on-site teacher.

Figure 2-1—Panhandle Shar-Ed Video Network



Schools in the Shar-Ed fiber optic network send and receive courses, broadening the curriculum available to all students in Beaver County.

Computer Networks

Although computer conferences are live events, much of the activity on computer networks is on a delayed basis. Computer networks are being used in innovative ways for both student and teacher activities. To encourage a class of writing-resistant seventh graders, a teacher paired her class with a class of fourth graders in another school. The classes exchanged letters, and the big brother/sister relationships worked to encourage writing by the seventh graders.[24] In a corn growing contest between elementary school students in the United States and Canada, data on the height of the corn plants were sent through the network every 3 days. Students also used the network to ask scientists about farming strategies and to share results with these experts.[25] The Interactive Computer Simulations developed by the University of Michigan School of Education uses telecommunications to study public affairs, such as the Arab-Israeli conflict. The university and school facilitators guide the students through the month-long conflict simulation. Students at the sites send private diplomatic messages, press releases,

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[24] L. Schrum et al., "Today's Tools," *The Computing Teacher*, vol. 15, No. 8, May 1988, pp. 31-35.

[25] Nancy Roberts et al., *Integrating Telecommunications Into Education* (Englewood Cliffs, NJ: Prentice-Hall, in press).

Photo credit: The University of Michigan College of Educ

Students at two Michigan schools take on the role of Arabs and Israelis in an interactive computer simulation. They send diplomatic messages, hold meetings, and take political and military actions over the network.

take political and military actions, and hold meetings, all through the network.[26]

Recorded Instructional Materials

Many materials are available only in recorded form. Audiovisual materials and filmstrips are older media technologies; interactive videodiscs are a fast-growing, emerging instructional technology. Together, this category represents the largest use of media technologies in education; almost all schools use tapes, films, filmstrips, or other media technology.[27] Such materials are widely used in both traditional and distance education classrooms.

Current Events Programming

National surveys have shown a startling lack of awareness on the part of secondary school students to politics, world events, and geography, among other subjects. In the 1989-90 school year, three news programs hoping to address this problem will begin programming specifically for schoolchildren. The Discovery Channel will offer *Assignment: Discovery*, in two, 25-minute segments each day. Each day of the week will be dedicated to a differ topic area.[28] Cable News Network (CNN) w produce *CNN Newsroom*, a 15-minute news a information program. Both cable-delivered p grams will be available to any school that is wi for cable; three of the largest cable operators in t country have offered to wire schools in their serv areas at no charge in conjunction with the CN program.[29] Another company, Whittle Communic tions, is offering *Channel One*, a daily satelli delivered news program. Two minutes of the 1 minute program will show commercials. In retu for showing the program to students, the schools w receive a satellite dish, television sets, and oth requisite equipment free of charge. The admission advertising in public schools has generated a gr deal of controversy in the educational community

Who Are the Providers?

Telecommunications technologies make it po sible to aggregate local, State, regional, and ev national needs. This aggregation, and the e panding education and technology needs

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[26] University of Michigan School of Education, *Interactive Communication Simulations: Inter-School Computer Mediated Learning Opportuniti* program information packet (Ann Arbor, MI: April 1989); and Edgar C. Taylor, Jr. and Frederick L. Goodman, "Computer-Mediated Simulations: T Global Classroom," *Academic Computing*, vol. 1, No. 1, spring 1987, pp. 52-56.

[27] Over 86 percent of the elementary and secondary schools in the United States have at least one VHS VCR; over 50 percent have two or more. Qua Education Data, *Video Purchasing Patterns in Schools* (Denver, CO: May 1986).

[28] The five subject areas are science and technology, social studies, natural sciences, arts and humanities, and world events and contemporary issu Mark Walsh, "Discovery Cable Channel Plans Documentary Programs for School Use," *Education Week*, vol. 8, No. 35, May 24, 1989, p. 5.

[29] "Turner to Launch 'CNN Newsroom' in High Schools," *Broadcasting*, vol. 116, No. 18, pp. 116-117.

[30] See, for example, pro and con articles by William S. Rukeyser and Scott D. Thomson in *Education Week*, section on "On Commercial Televisi in Schools," vol. 8, No. 26, Mar. 22, 1989, pp. 23, 25. Also, see Joe Sharkey, "Whittle Sweetens Schoolroom TV Plan to Blunt Criticism of News, Format," *The Wall Street Journal*, June 9, 1989, p. B3; and "In School: Subsidized News Is Worth a Test," *The New York Times*, editorial, Mar. 12, 19 p. E24.

schools, has brought a widening array of providers to the education market. Many of these providers are members of the traditional public education community, while others are from the private sector. They supply the K-12 community with a variety of programming, services, and hardware. Teachers and outside experts can be provided by other districts, the higher education community, or the private sector. Hardware and software companies offer programming and technical assistance. Public and commercial broadcasting stations, cable and local instructional television systems, and local or regional telephone companies and satellite distributors can provide the means to connect different sites. Although most schools will continue to offer much of their own instruction, many are likely to turn to outside suppliers to obtain educational and telecommunications resources.

Local School Districts

Many K-12 distance learning projects are locally based. Local networks enable schools to pool students and teachers, and to maintain the traditional involvement and control of local interests in public education. In Minnesota, two-way interactive video via microwave, cable television, Instructional Television Fixed Service (ITFS), or fiber optic cable links districts with one another; by the 1989-90 school year, one-third of all school districts in the State will be served by some form of distance learning. Many sites do not have a teacher, facilitator, or any adult monitor in the remote teaching classrooms. A school district in Louisiana uses fiber optics to connect parochial school students to instructional programming provided by the public school's Integrated Learning System.[31] The Bismarck, North Dakota school district (the largest district in the State) originates Spanish instruction for six small rural schools through a network of computers and simultaneous telephone conferences. Each small school pays part of the salary of the teacher in the host school.

The great appeal of local distance learning projects is community control over curriculum and instruction. Each district or area uses its own teachers, and structures courses and other activities to meet community needs and fit local standards. For many, these are important qualities that larger national projects lack. However, the quality of some local efforts is restricted by the availability of teachers willing and well suited to teach over these systems. Some projects are undertaken without appropriate teacher training or attention to production quality; distance learning can then fall short of its potential.

Regional Education Service Agencies

Regional education service agencies exist in almost every State and function to pool local school districts' resources to address common needs. Many local districts have used these agencies to provide distance education technology and programming. The STEP network in Washington State and the Telelearning Project in New York State (see chapter 1, boxes 1-A and 1-B, respectively) are both examples of curriculum provision by regional education service agencies. In Connecticut, the Area Cooperative Educational Services distance learning consortium brings together students from Amity, Hamden, Cheshire, New Haven, and North Haven high schools. Fiber optics link the sites; students are offered 14 different classes via two-way video and audio transmission. Providing Academics Cost Effectively (PACE) is a cooperative interactive television effort spearheaded by the Cheboygan-Otsego-Presque Isle Intermediate School District (ISD) in northern Michigan. Expansion plans (using fiber, ITFS, and cable) to reach all districts within the ISD, and the Charlevoix-Emmet ISD, are under way.[32] Like local school district projects noted above, distance learning efforts produced by regional education service agencies are positioned to be particularly responsive to local needs and interests.

States

The State role in K-12 distance education is critical in developing infrastructure, providing funding for projects, and promulgating policies and regulations guiding development for distance learning programming. (See chapter 5.) Few States are providing programming for students; more are using their statewide systems to deliver teacher training. North Carolina, for example, produced short courses and full courses for their teachers. (See chapter 5, box 5-A.) Kentucky is presently constructing a statewide satellite system, with a downlink at each of the more than 1,300 elementary and secondary schools in the State.

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[31] Angela Mielke et al., "Teaching at the Speed of Light: The Fiber-Optic Connection," *T.H.E. Journal*, vol. 16, No. 8, April 1989, pp. 77-78.

[32] Cheboygan-Otsego-Presque Isle Intermediate School District, "PACE Information Manual," unpublished document, Jan. 1, 1989.

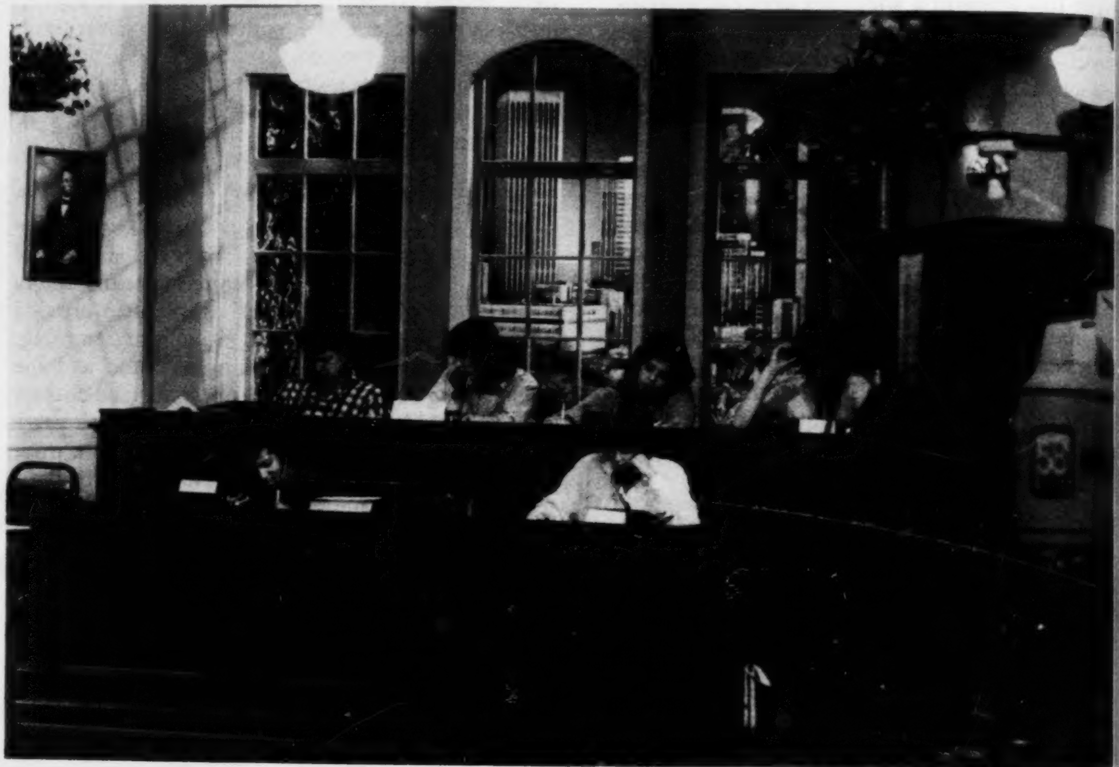

Photo credit: KLCS-Channel 58, LA Unified School Dist

The Los Angeles Unified School District offers a Homework Hotline over its educational television station. After school, students call in questions and get to see their problems solved during the broadcast.

Higher Education

School districts can also turn to local institutions of higher education for programming and telecommunications resources. In many cases, colleges and universities have instructional and technology resources that schools can use. The opportunity for these institutions to expand revenues and make greater use of existing resources has led to some cooperative arrangements with local districts as well as with multistate or national projects, such as the Star Schools projects.

The Rochester Institute of Technology in New York State uses audiographics and other technologies to bring its instructors to local schools that pool money to pay the professors' salaries. Some of these classes are dual credit classes, allowing students t receive college credit while still in high school.[3 Western Montana College created the Big Sk Telegraph Network, a computer network linking 11 one-room schools, librarians, and others throughou the State. Teachers share ideas, answer questions, request software and library books, and take classes over the network; students and economic development specialists are also using the system.

Colleges and universities see these arrangements as an effective way to recruit students to the institution and to increase the preparedness of new students. The benefits for local schools include access to a wider array of educational and technical resources, including experts in various fields of

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[33] Susan M. Rogers, director, Distance Learning Projects, Rochester Institute of Technology, personal communication, April 1989.

study, and a greater breadth and depth of educational materials.

Public Television

PBS and public television stations around the country reach 94 percent of American households and can be received by schools that serve 29 million students.[34] Since its inception in 1969, PBS has been broadcasting and delivering by satellite enrichment programming, teacher teleconferences, documentaries, and one-way courses to schools. Familiar fare, such as *Sesame Street* and *3-2-1 Contact*, is regularly incorporated into classroom instruction; *Nova* and *National Geographic Specials*, among other documentary programming, are also used by teachers throughout the country. PBS often provides print and other support materials to accompany its educational programming. Teachers can expand their science curriculum by using *The Voyage of the Mimi* series and accompanying text and software in secondary school science classes.[35] Professional development programming has been greatly expanded in recent years; many live teleconferences are held each year, and PBS' Education Clearinghouse offers professional development video programs through "Video File."[36]

Future PBS education-related efforts include the "Education Pipeline," a project being tested that will deliver via satellite educational software, text, and teacher guides and handouts that accompany instructional programming. PBS also offers an extensive range of one-way live courses for college credit through the Adult Learning Service.

Individual public television stations are also involved in distance education. WHRO, a public television station in Norfolk, Virginia, has extensive telecommunications facilities including satellite uplinks and downlinks, microwave conections to other public television stations around the State, and an ITFS system that transmits distance education programming to local schools. Nearby, Old Dominion University (ODU) provides programs from its three electronic classrooms to the WHRO network.[37] ODU also produced the three-part *USA-USSR Youth Summit Teleconference Series*, including one international teleconference between American and Soviet teenagers. Organized to support international studies curricula for grades 7 to 12, this teleconference was carried by 155 PBS-member stations.[38]

Public television stations and PBS provide a significant resource for education in this country today. Because of their national focus, and their investment in and commitment to broadcast technologies, PBS will continue to offer predominantly one-way programming, both live and delayed. The ubiquity of the public television and public radio networks makes them valuable educational providers.

Other Educational Institutions

Other institutions with public and educational outreach responsibilities are involved in distance learning. These include museums, laboratories, science centers, and agencies of the Federal Government. The Talcott Mountain Science Center (Connecticut) Sci-STAR satellite program reaches students and teachers in 30 States. The series brings experts in such fields as superconductivity and planetary exploration into the classroom electronically, allowing students at remote sites to watch live experiments, ask questions, and conduct their own followup activities inspired by the example of these working scientists. The National Aeronautics and Space Administration, long a pioneer in distance education, currently produces four teleconferences a year for teachers on current issues and suggested activities related to space science.

A Note on Provision of Content v. Delivery of Content

In any discussion of providers, especially commercial providers, it is important to distinguish between content for classrooms and services to deliver that content. Many organizations that deliver an electronic signal to the school do not take part in the programming. These include satellite systems (satellite owners such as GTE and Hughes), cable television systems (numerous cable operators around the country who provide channels for schools to use), and telephone providers (local, independent, and long distance telephone companies). Many of the providers discussed in the preceding paragraphs—local school districts, States, higher education institutions—provide the course content, and then contract with one of these service providers to transmit their materials to the schools.

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[34] U.S. Department of Commerce, National Telecommunications and Information Administration, *Public Broadcasting Coverage in the United States* (Washington, DC: U.S. Government Printing Office, July 1989).

[35] Dee Brock, senior vice president, Education Services, Public Broadcasting Service (PBS), personal communication, July 1989. *The Voyage of the Mimi* is a widely acclaimed series targeted to grades four to eight, produced by the Bank Street College of Education. PBS does not produce any programs itself; it obtains and distributes programs from public television stations, independent producers, international sources, and others. Public Broadcasting Service, "The Voyage of the Mimi," fact sheet, 1988; and Public Broadcasting Service, "Facts About PBS," unpublished document, January 1988.

[36] Public Broadcasting Service, "Elementary/Secondary Service Newsletter," January, July, and September 1989.

[37] OTA site visit, March 1989.

[38] Chet Tomczyk, Elementary/Secondary Service, Public Broadcasting Service, personal communication, July 1989.

In contrast, other providers control both content and delivery method. ITFS licenses, for example, are reserved for educational institutions; therefore, in most ITFS systems the educational entity creates and delivers the instruction.

The trend is toward combining content and delivery. Companies previously serving as delivery vendors, such as satellite owner Hughes Aircraft and phone companies NYNEX and US West, are attempting to become content providers.[39] Cable providers such as The Learning Channel and Mind Extension University create some of the educational material and control part of the delivery of that material; satellite providers like Oklahoma State University and TI-IN Network do the same. The distinction does, however, represent two ends of the spectrum of offerings.

Commercial Providers

Private sector involvement is increasing rapidly, due to many factors. Companies want to expand their markets, improve the quality of education of their future workers, improve curriculum choices and quality, and expand delivery of their services. Commercial providers supply programming, equipment, and technical expertise, although providing content is prohibited in some cases.[40] Some companies (for example, some cable television operators) are involved in the production as well as the distribution of education materials.

Satellite—One of the first private compani
offer courses to local schools was the TI-IN
work. Started in 1986 through a cooperative arra
ment with Texas' Education Service Center, Re
20, TI-IN currently offers 25 courses via satelli
over 4,000 students at 780 schools in 32 States.
maintains dedicated transponders on a comme
satellite, and transmits hundreds of hours of
gramming to schools every month.

Cable—There has been a recent flurry of int
in educational programming in the cable indu
several individual cable companies are develo
programming to meet educational needs. The Le
ing Channel, in existence since 1980, produc
wide range of programming for high school
college students, adults, and teachers. Availab
an estimated 20,000 schools and 17 million ho
holds through cable television, The Learning C
nel offers many complete mathematics, science,
literacy courses for secondary school stud
college credit courses in many subjects, and s
nars on topics such as AIDS and education. M
Extension University, launched in late 1987,
cable television channel dedicated to educati
programming. Several cable companies have for
the Alliance for Cable Education, to better serve
expanding marketplace. Although cable installa
extends to over 80 percent of the country, sc
access is still quite limited, and this will be one
of concern addressed by the Alliance.[41]

Public Telephone Network—Local and regi
telephone companies serve distance educa
through the transmission of voice, graphics, and
over the public network, and the managemen
dedicated (private) networks for video which
carried through public facilities. Local and regi
telephone companies are prohibited from delive
video over the public network at this time becaus
restrictions resulting from the Cable Act of 198

Computer network projects such as the Phy
Forum in Massachusetts[42] and audiographics

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[39] Hughes Aircraft is considering a plan to provide programming to grades three to five in inner-city schools via satellite. Norman Avrech, Spac
Communications Group, Hughes Aircraft Co., personal communication, September 1989. The telephone companies are actively working to remo
restrictions that prohibit them from providing video on the public network.

[40] Ibid.

[41] Access to cable services can mean many things. "Sometimes it means a cable drop has been made near or at the school door, sometimes it
a cable is in the vicinity but not at the school property, and frequently it means the school has been wired but the wire runs to one room, such as a l
or office, and access to the room isn't easy." Lyle Hamilton, manager, Broadcast Services, National Education Association, personal communic
Aug. 21, 1989. Even with access, schools may be limited in their use of cable or other video programming by shortages of television sets and

[42] The Physics Forum is a network for physics teachers in Massachusetts where teachers can exchange lesson ideas, hold conferences, tap in
banks, and download public domain software. Tom Vaughn, "Don't Be Isolated: Telecommunicate," *On Cue*, vol. 1, No. 3, March 1988, pp. 11.

ects, such as the Delaware-Chenango Board of Cooperative Educational Services (BOCES) Telelearning Project, use public phone lines to carry voice, data, and graphics. Telephone companies have also worked with educational institutions to provide telephone lines for video-based distance learning. For example, the Long Island BOCES project uses a fiber optic private network to provide two-way video and audio; the fiber optic cables used are leased from New York Telephone and dedicated to the BOCES project.

Hybrid Organizations and Consortia

Many distance education providers are really combinations of the types mentioned above. The Star Schools projects, for example, are required to build consortia that bring together local education agencies, State departments of education, institutions of higher education, public television stations, and/or private and nonprofit entities. Some or all of the members of the consortia provide programming for the network as a whole. (See chapter 6 for a description of the four Star Schools projects.) Also, numerous distance learning systems are run for the benefit of different communities of users. The Vermont Interactive Television (VIT) project is a joint venture of the Vermont State Colleges, Vermont Department of Education, Vermont Agency of Economic Development and Community Affairs, Vermont Department of Employment and Training, North Country Area Vocational Center, and New England Telephone. VIT is gradually expanding after a successful demonstration year to serve the videoconference, training, and instructional needs of State agencies, business and industry, vocational schools, primary and secondary schools, and higher education.[43]

A Note on Institutional Relationships in Distance Learning

Distance learning has fostered many new institutional arrangements for the provision of curriculum and instructional services. Reasons for this include the large start-up costs needed to implement many systems. Such costs drive districts and providers to seek out others to create economies of scale. Second, institutions and people with prior experience in distance education are usually outside of the elementary and secondary schools. Most often, community colleges, universities, business users, and business providers are the local or regional experts in distance learning provision. Third, the wide number of technologies available has brought many technology providers, as well as many content providers associated with a particular technology (e.g., cable television) to the education doorstep. Lastly, demands for telecommunications networks have emerged in other segments of the community. Education has been able to forge partnerships with governments, the business community, and others with convergent needs; such partnerships can significantly reduce the costs of information highways to all.

New institutional connections expand the domain of colleagues and institutional expertise available to classroom teachers and local school districts. New resources flow into a school via distance learning. Greater community involvement and commitment can be secondary outcomes of expanded roles for other players in the schools.

These very same connections can also create significant tensions. Control issues arise along two dimensions: control of the content and processes of instruction, and control over the telecommunications resources necessary for delivery. In the area of education policy, issues of certification and local v. State control of curriculum become important. Business or other groups outside of education may expect more say in how the shared resources are used in the schools than the local education authority deems appropriate. In the telecommunications arena, the needs and concerns of the education community may be far from the prime concern of policymakers. In both arenas, **educational leadership in planning, goal setting, and allocation of resources will ultimately determine the quality and availability of distance learning.**

How Are Distance Learning Systems Being Paid For?

Funding solutions for distance education are as varied as technical solutions. Arizona, for example, issued bonds to cover construction costs. The Kentucky legislature voted $11.3 million to install satellite dishes on every school in the State, while the Iowa legislature authorized $50 million for the construction of that State's educational telecommu-

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[43] Vermont State Colleges, "Vermont Interactive Television Evaluation Report," unpublished document, Sept. 27, 1988. By 1992, Vermont Interactive Television plans call for 90 percent of the population of the State to be within 25 miles of a transmission site.

Photo credit: Apple Classroom of Tomorrow, Nashville

Do students learn? More research is needed, but evaluations to date have been encouraging.

nications system. (See chapter 1, box 1-A.) The State of Connecticut has a grant program for local projects. (See chapter 5, box 5-B.) One of the more innovative funding solutions is Missouri's tax on videotape rentals; revenues are expected to reach $5 million in the first year of the tax.

For small school districts, the question of funding is especially critical. A high school with only 90 or 100 students cannot afford the thousands of dollars it may take to get an effective distance learning project into place. In some cases, districts who need the systems the most are least able to afford them, and outside assistance is required to provide any educational services via distance learning.

Is Distance Learning Effective?[44]

Much of the research on distance learning eval
ates its effectiveness in higher education and bu
ness. **This effectiveness literature has been qu
consistent: when used in business, military trai
ing, and adult learning, there is no significa
difference in effectiveness between distan
learning and traditional instruction metho
and student attitudes are generally positive abo
the experience.**[45]

This conclusion, however, does not necessari
extend to the K-12 setting. Little research exists th
specifically addresses K-12 distance education, a

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[44] This section of the report draws heavily on Moore, op. cit., footnote 2.

[45] Ibid., p. 7.

what does exist is limited in scope and often anecdotal. Few long-term evaluations have been conducted, partly due to the newness of many systems. One review of the literature, for example, found 503 documents that related to distance education, of which only 46 examined K-12 applications. In addition, there were "... no studies comparing effectiveness of instruction across types of population (general K-12, exceptional students), no effectiveness data comparing different content areas, and none comparing the effectiveness of instruction using different instructional designs."[46] The literature regarding the effectiveness of teacher inservice and staff development is similarly lacking.[47] The literature that is available, however, is enlightening for the present and suggests future directions for research and evaluation in the field.

Effectiveness Studies— A Look at the Literature

Video-based interactive instruction is the distance learning format that most closely resembles the traditional classroom. This has been the format of choice for many distance learning systems. The primary effectiveness question asked, then, about video-based, interactive distance learning is: "Do students learn as much through distance learning as through face-to-face instruction?" There are, however, other important considerations that go into assessing the overall effectiveness of learning systems. Some of these outcomes include:

- learner achievement (the above-noted "primary" question),
- learner perceptions and attitudes,
- course and curriculum design considerations,
- inservice training effectiveness, and
- cost-effectiveness.

Learner achievement is the primary question asked about distance learning: "Do the students learn as much through distance learning as their counterparts in traditional classrooms?" One survey of K-12 and adult distance education literature suggests that students learn as well in distance education programs as they do in regular programs.[48] Iowa's two-way interactive television (TWIT) project found no significant differences between these classes and other sections of the same class taught face-to-face by the same teachers. Daily lesson scores, test scores, grades, and levels of participation were comparable for the two groups.[49] Similarly, a wide range of elective progamming provided from 1983 to 1986 in rural Minnesota showed no statistically significant differences in achievement by the distant learning students compared to students in a traditional class.[50] A much longer list of evaluations of adult learners indicates that delivery of educational programming via teleconferencing is educationally effective.[51]

Research has also sought to understand **learner perceptions and attitudes** in three areas: assessing learner satisfaction with the course; discovering perceptions of the technologies' effect on the instructor/student interaction; and examining student perceptions of teaching methods. Two surveys of K-12 project evaluations reported generally positive student attitudes.[52] In one example, the Iowa TWIT system reported very positive results: 97 percent indicated no more problems in the televised classes than in traditional classes, and 67 percent thought students accepted more responsibility for their behavior and learning in televised classes.[53] However, a survey of an early satellite project was generally negative: 65 percent believed their televised class to be more difficult than their regular classes, and almost 70 percent said they would choose a traditional course over a satellite course.[54]

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[46] William D. Eiserman and David D. Williams, *Statewide Evaluation Report on Productivity Project Studies Related to Improved Use of Technology to Extend Educational Programs. Sub-Report Two: Distance Education in Elementary and Secondary Schools. A Review of the Literature*, ERIC, ED 291 350 (Logan, UT: Wasatch Institute for Research and Evaluation, 1987).

[47] Moore, op. cit., footnote 2, p. 21.

[48] Anne Batey and Richard N. Cowell, *Distance Education: An Overview*, ERIC, ED 278 519 (Portland, OR: Northwest Regional Educational Laboratory, 1986).

[49] Robert N. Nelson, "Two-Way Microwave Transmission Consolidates, Improves Education," *NASSP Bulletin*, vol. 69, No. 484, 1985, pp. 38-42.

[50] Will Kitchen, "Education and Telecommunications: Partners in Progress," ERIC, ED 282 551, testimony before the Senate Committee on Labor and Human Resources, Mar. 11, 1987.

[51] Moore, op. cit., footnote 2, pp. 9-12.

[52] D. William Quinn and David D. Williams, *Statewide Evaluation Report on Productivity Project Studies Related to Improved Use of Technology to Extend Educational Programs. Sub-Report Three: Survey of Technology Projects Throughout the United States*, ERIC, ED 291 351 (Logan, UT: Wasatch Institute for Research and Development, 1987); and Batey and Cowell, op. cit., footnote 48.

[53] Nelson, op. cit., footnote 49.

Many studies of adult learners indicate generally positive attitudes toward telecommunications instruction.[55] One study looked at student perceptions of teaching behaviors necessary for effective instruction in both conventional and teleconferencing instruction. This study found five statistically significant factors in effective teleteaching: effective teleteachers used students' names, set out clear statements of purpose, made use of printed material, encouraged discussion, and did not speak in a monotone.[56]

Research in effective **course and curriculum design** has focused on overcoming the differences between the distant and local classrooms. One study introduced the concept of "teletechniques," a set of components taken for granted in face-to-face instruction but not automatically found in distance education. These components include the need to humanize the teaching experience (create rapport with students); encourage participation (ensure interaction between students, and between students and teacher); attend to message style (vary tone of voice and volume, using videos and other visual aids); and provide regular feedback (monitor student interest).[57] Other researchers have applied these criteria to effectiveness studies.[58]

Inservice training is widely offered via telecommunications. Effectiveness research has been very limited, but is generally positive. One study of teachers being retrained in mathematics instruction found the remote learners doing better than the face-to-face group.[59] Another controlled study found that while a majority of teachers felt the teleconferencing instruction was either acceptable or preferable, a substantial minority felt it was an undesirable method. Both the face-to-face learners and the distant learners in this study rated the instruction equally effective.[60] Distance delivery of inservice training, like other forms of training for audiences of professionals, is likely to be effective if designed well. The literature does not appear to fully address special needs of this group of learners. Research questions in the future may include attitude questions, such as whether an audience of teachers is inherently critical of such instruction (or more inclined to react favorably), or whether such an audience feels particularly threatened by the technology.

Assessing **cost-effectiveness** of distance education is difficult. Many of the benefits of distance learning, such as increasing parental and community involvement in the schools and exposing students and teachers to new technologies, cannot be quantified. Such an analysis requires some comparison with another delivery method; many distance education projects exist precisely because there is no other method available. Attempting to establish cost-effectiveness begs many questions about what constitutes effective education, and what value to place on results.

Some economic models have been devised that attempt to analyze costs associated with distance learning. Most of these models analyze costs in business, higher education, and inservice training.[61] One suggested approach for K-12 distance education is the "ingredients method."[62] This method involves the identification and specification of all relevant inputs; a typical list of ingredients would begin with personnel, facilities, equipment and materials, and in-kind contributions from participating sites.[63]

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[54] Bruce O. Barker, "The Effects of Learning by Satellite on Rural Schools," ERIC, ED 284 693, paper presented at the Learning by Satellite Conference, Tulsa, OK, Apr. 12-14, 1987.

[55] J.J. Boswell et al., "Telelecture: An Experiment in Remote Teaching," *Adult Leadership*, vol. 16, No. 9, 1968, pp. 321-322, 338; D.P. Hoyt and D. Frye, Kansas State University, "The Effectiveness of Telecommunications as an Educational Delivery System," unpublished manuscript, ERIC, ED 070 318, 1972; G.R. Christopher, "The Air Force Institute of Technology—The Air Force Reaches Out Through Media: An Update," *Teleconferencing and Electronic Communications*, L. Parker and C. Olgren (eds.) (Madison, WI: University of Wisconsin—Extension, Center for Interactive Programs, 1982), pp. 343-344; and J. Kruh, "Student Evaluation of Instructional Teleconferencing," *Teleconferencing and Electronic Communications II*, 1983, pp. 293-301.

[56] B.A. Haaland and W.G. Newby, "Student Perception of Effective Teaching Behaviors: An Examination of Conventional and Teleconference Based Instruction," *Teleconferencing and Electronic Communications III*, 1984, pp. 211- 217.

[57] L. Parker and M. Monson, "Teletechniques: An Instructional Model for Interactive Teleconferencing," *The Directional Design Library*, vol. 3 (Englewood Cliffs, NJ: Educational Technology Publications, 1980).

[58] Jocelyn A. Hezekiah, "Teletechniques: A Case Study in Implementation and Evaluation," *Teleconferencing and Electronic Communications V*, 1986.

[59] B.G. Nunley, University of Texas, "A Study of the Effectiveness of Telelecture in the Retraining of Elementary Teachers in Mathematics," unpublished doctoral dissertation, 1965.

[60] Joseph M. Kirman and Jack Goldberg, "One Way Television With Simultaneous Telephone Group Conferencing Using Satellite Maps as a Monitoring Device," A Report to the Innovative Projects Fund, ERIC, ED 224 460, 1980.

Effectiveness Studies— A Look at Ongoing Projects

The research literature provides one look at evaluation efforts going on in distance education today. Perhaps more useful is a snapshot of current projects, several of which are generating unpublished surveys and project evaluations that are providing current, localized feedback.[64] Examples of these unpublished surveys show how existing efforts are monitoring and correcting their course.

A pilot project in Texas evaluated three different "telecourse" delivery efforts in the State. This project had as its goal the development of evaluation standards for the future.[65] Both student test results and participant reactions were monitored. Student test results in the telecourses were equal to or better than their counterparts in traditional classes, but their perceptions were different. Telecourse students rated their courses as harder, felt they learned less, felt that asking questions was more difficult, and said they needed teacher conferences more often.

Minnesota conducted a study of the State Technology Demonstration Sites; these are a number of small projects grouping schools in a single district or across districts, using multiple technologies for two-way instruction which they call "Interactive Television" (ITV).[66] The study analyzed effects on students (attitude, achievement, classroom climate and interaction), on teachers, and on the districts. Costs were identified, but the evaluation did not address issues of cost-effectiveness ". . . given the difficulties associated with fair comparisons of costs incurred in ITV programs and costs incurred in traditional forms of schooling."[67]

Student attitudes were generally favorable after an initial adjustment. Only 30 percent of the students took ITV classes because that was the only way to take the class. Of the students who dropped out of the ITV classes, 55 percent indicated that television influenced that decision; however, just over 50 percent of the students dropping these classes said they would take another ITV class. Achievement data overall showed no significant difference for the student population at large. Classroom interactions were measured and reported in this study, and showed no difference between ITV and traditional classes. ITV magnifies several things ("dead" time, personal and teaching styles, effectiveness of a good teacher and weakness of a poor one) but those teachers who were highly interactive and involving in traditional classrooms were equally successful on ITV.

Teacher attitudes were generally favorable toward ITV; 75 percent said they would choose to teach again on the system. Seventy percent of those teachers surveyed believed teaching on ITV required them to change their style or method of teaching, which was seen as both a problem and an opportunity. Teachers believed their students liked the ITV classes, spent as much time on task, and were frequently more motivated than traditional class students. Surveyed teachers noted that ITV chal-

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[61] Sarah Rule et al., "An Economic Analysis of Inservice Teacher Training," *The American Journal of Distance Education*, vol. 2, No. 2, 1988, pp. 12-22; Alan G. Chute and Lee Balthazar, *An Overview of Research and Development Projects at the AT&T National Teletraining Center* (Cincinnati, OH: AT&T National Teletraining Center, 1988), p. 4; Hal Markowitz, "Financial Decision Making—Calculating the Costs of Distance Education," *Distance Education*, vol. 8, No. 2, 1987; R.G. Showalter, *Speaker Telephone Continuing Education for School Personnel Serving Handicapped Children: Final Project Report 1981-82*, ERIC, ED 231 150 (Indianapolis, IN: Indiana State Department of Public Instruction, Indianapolis Division of Special Education, 1983); Christopher, op. cit., footnote 55.

[62] Richard Clark, University of Southern California, "Evaluating Distance Learning Technology," OTA contractor report, May 1989, pp. 20-24.

[63] Henry Levin, *Cost Effectiveness: A Primer* (Beverly Hills, CA: Sage Publications, 1983); and Henry H. Levin, Stanford University, "The Economics of Computer-Assisted Instruction," unpublished manuscript, May 1988, p. 3. For a broader discussion of cost-effectiveness, see OTA, op. cit., footnote 5, pp. 74-83.

[64] A look at the list of distance learning projects in this report (app. A), reveals a limited number of these evaluative efforts to date. Most resources are being committed to immediate implementation of systems, e.g., hardware purchases and teacher training. One explanation for this is that the needs being served by these systems are pressing, creating a strong action agenda.

[65] The three projects studied included a videotaped Spanish course, interactive courses offered via satellite statewide, and interactive courses offered via microwave region-wide. Texas Education Agency, "Serving the Needs of Telecourse Students: A Pilot Project to Develop Evaluation Guidelines," unpublished document, 1986.

[66] Diane L. Morehouse et al., "Interactive Television: Findings, Issues and Recommendations," unpublished document, Feb. 1, 1987.

[67] Ibid., p. 7.

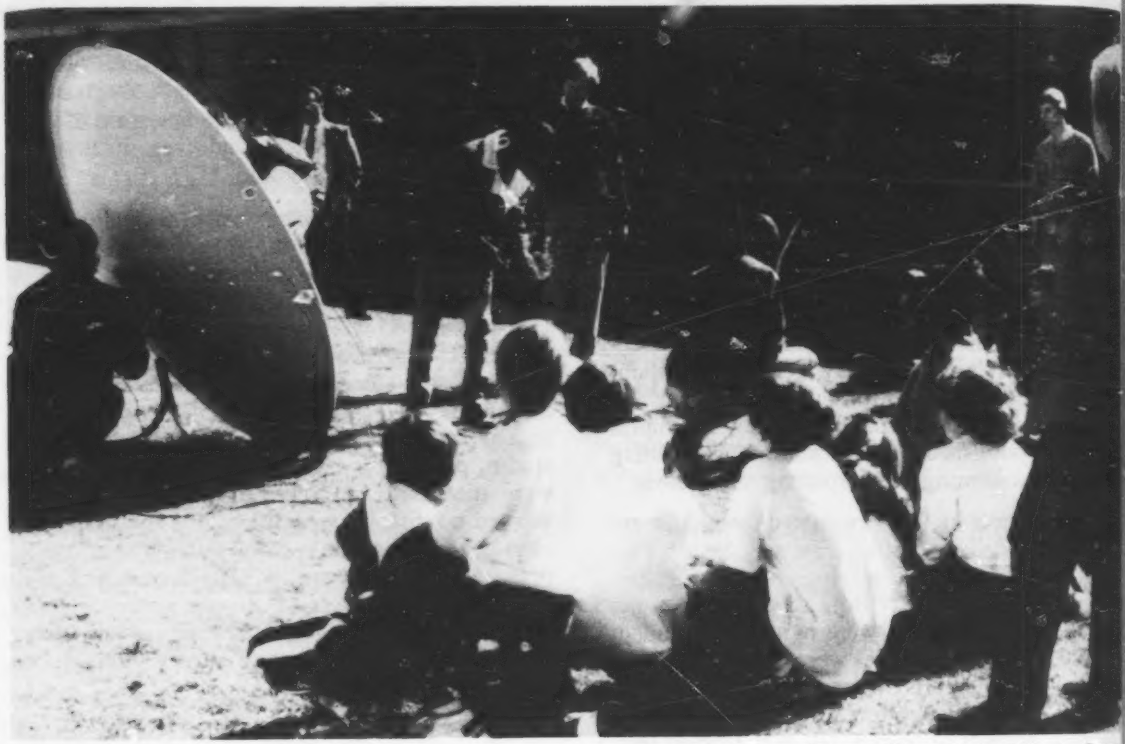

Photo credit: Louisiana Educational Resources Network, Southern University—Shreve

When they are involved in distance learning activities, students learn to manipulate the tools of the information age.

lenges teachers to grow, and enlarges options for students. Teachers also felt that discipline problems were greater in ITV,[68] movement was restricted in the classroom because of the cameras, and technical problems were an obstacle.

SERC, one of the four Star Schools Program grantees, will be offering high school courses and staff development courses during the 1989-90 school year to students in 22 States via satellite. During the second semester of 1988-89, SERC conducted pilot classes for high school students and teachers. Two high school classes were offered, with enrollments of 160 and 204 students, an average of three to four students per school. An independent evaluation study was undertaken to profile the population taking the classes, determine the effectiveness of the classes and the technology that supported it, compare participants' attitudes before and after the semester, and compare interacti satellite delivery with traditional instruction.[69]

Many observations were recorded by this surve a few are detailed here. Although all classes we recorded and made available to students, and a though many students complained that the cla continued to be transmitted during vacation time more than one-third of the high school stude never borrowed a tape for review. Only 40 perce of the high school students felt there was suffici opportunity to interact with the teacher. The studen overwhelmingly approved of the opportunity to ta classes otherwise not available, and two-thir would take another class via interactive televisio

Facilitators in the remote classrooms were su veyed, and reported that motivating students a helping students with content questions were the primary duties. Only three of five facilitators fe prepared to answer student questions. Facilitators spent 6 to 10 hours a week on SERC responsibilities, and felt the training sessions, handbook, and hotline provided by SERC to be helpful. Twenty-five percent of the facilitators felt that interactive television was not as effective as regular instruction, although almost all felt the students received excellent instruction. More than 80 percent of them would be willing to serve as facilitators again.[70]

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[68] Most of the classes had no facilitator or other adult in the receiving classrooms. Ibid., p. 2.

[69] Toby Levine Communications, Inc., "SERC Pilot Semester Evaluation Project," vol. 1, unpublished document, July 1989.

Participant reactions such as those noted in the above examples provide much useful information. It is from participant reaction data that most unanticipated problems and benefits are uncovered. For example, the InterAct Instructional Television Network in Houston discovered that students in small rooms were helping each other a great deal while the teacher was talking. They could do this without disrupting the teacher or the other students, and could prepare responses and then activate the microphone to join into the discussion or answer a question. Some of the tutors hired to supervise the rooms were discouraging this behavior, assuming that talking indicated a discipline problem. Training the tutors to encourage this cooperative learning method is an easy correction resulting from this participant survey.[71]

Evaluations are most effective when they are created and planned for during the initial program planning. One significant benefit of this approach is that evaluation plans require an articulation of what, in fact, are the measures of change sought. This process will result in clearly articulated goals and objectives for the entire effort, as well as a commitment to timely feedback.[72] For example, the Midlands Consortium, another of the Star Schools grantees, has proposed a research agenda for the 1989-90 school year.[73] This agenda is directed at investigating whether instructional television is especially useful or especially inaccessible to high-risk students.[74] Midlands hopes to target research questions to evaluate how each different group of learners perform and react. Because of the Federal requirement to serve at-risk students through the Star Schools Program, this research may be valuable in determining instructional television's efficacy with these students.[75]

A Final Note on Measuring Effectiveness

Some of the most important outcomes of distance learning may not be reflected in student test scores. Effectiveness is enhanced by offering students a chance to interact with peers from a range of socioeconomic and educational backgrounds at other schools,[76] providing diverse educational experiences for students, increasing parental involvement with courses, and exposing students and teachers to new technologies. The school environment and the community it serves can also benefit from distance education because of increasing cooperation between schools and districts and bringing in classes for adults, among others.[77] Overall program effectiveness is thus a difficult measurement to make. To the extent that distance education can create benefits such as those above, it may be claimed to be effective even without addressing the issue of how it impacts learning directly. Evaluation of ongoing projects can further delineate benefits, costs, and impacts of telecommunications technologies in the schools. Also, research over an extended period of time will help answer questions about whether the novelty of the technology itself may be producing positive outcomes. If this is so, once such efforts become routine, effectiveness may fall off and more accurate measures of the value of the system may emerge.

Distance education represents more than just a substitute for the classroom. The ability to manipulate the tools of communication are a critical requirement for a worker in the information age.

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[70] Ibid., pp. 6-11.

[71] Clark, op. cit., footnote 62, pp. 7-11; and Barker, op. cit., footnote 6.

[72] Clark, op. cit., footnote 62, pp. 10-12.

[73] Although two of the Midlands partners have been broadcasting via satellite for a few years now, the Midlands Consortium itself is beginning its first year. Midlands Consortium Research and Evaluation Committee, "Midlands Consortium Research Agenda for 1989-90 School Year," unpublished document, June-July 1989.

[74] Ibid., p. 3.

[75] Many observers believe that self-motivated students are best able to take advantage of distance learning opportunities. Extensive use of distance learning for adult learning, training, and gifted and talented classes has reinforced this belief; however, no research has conclusively addressed this issue.

[76] Sometimes students who are at the top of their small rural high schools find it a challenge to interact with other bright students in diverse distance classrooms.

[77] Batey and Cowell, op. cit., footnote 48.

Much of business and industry today is conducted through computers, electronic mail, facsimile machines, and video conferences. Not merely a second choice, distance learning provides students a foretaste of the adult world they will be entering.[78] The benefits are largely unmeasurable by effectivene research, but suggest the critical impact alternati experiences can have on today's student.

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[78] Jim St.Lawrence, SL Productions, personal communication, September 1989.

Chapter 3

Technology Links: Choices for Distance Learning Systems

Photo credit: AT&T Archives

Microwave radio relay tower, Albany, TX

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Chapter 3

Technology Links: Choices for Distance Learning Systems

INTRODUCTION

Ten years ago the technological options for delivering education over a distance were limited. Today, they are numerous and growing. **Advances in information and telecommunications technology are rapidly expanding learning opportunities and access to educational resources beyond those immediately or traditionally available.** These technologies, both new and old, allow users to transmit, receive, create, and combine information in many new ways. Such advances are a major force in the explosive growth experienced by distance learning in business, higher education, and now K-12 schools in the last several years.

Today's technologies are faster, more powerful, and more flexible than comparable technologies of only a few years ago.[1] The technologies of telecommunications and information processing are also increasingly integrated; technological systems are more intelligent and are more capable of being interconnected with other technologies. The use of digital technology is rapidly changing the nature of telecommunications and information processing, allowing more types of information to be sent, stored, and manipulated more easily and quickly. Finally, easily customized services and hardware allow users to choose and combine technologies in ways that best suit their needs. These developments give educators and students a new set of capabilities and opportunities for teaching and learning.

Schools trying to match technological options to educational needs have a wide range of choices. A number of technologies and technology systems can be used, either separately or in combination. Many of these actual systems were described in chapter 2. Technical choices are best defined by the specific demands of each distance learning situation. A broad examination of the current technologies show what applications the technologies allow and what restrictions they place on teaching and learning. This chapter discusses the technologies for distance learning; analyzes their capabilities and limitations; and discusses relevant regulatory concerns, issues, and implications for the future.

FINDINGS

- **Many technologies are being used to provide education over a distance.** Transmission systems include satellite, fiber optics, Instructional Television Fixed Service (ITFS), microwave, the public telephone system, and coaxial cable. Any of these technologies can be interconnected to form "hybrid" systems. **No one technology is best for all situations and applications.** Different technologies have different capabilities and

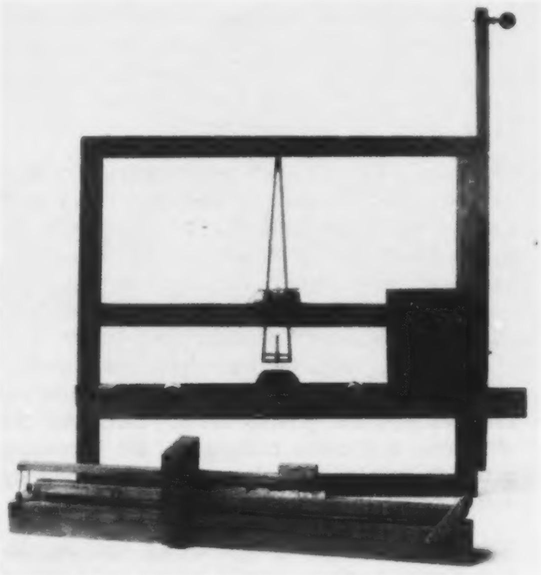

Photo credit: Smithsonian Institution

"Its mighty triumphs are but half revealed, and the vast extent of its extraordinary power but half understood."
—an 1851 assessment of the potential of the telegraph.

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[1] For a complete review of the forces driving technological change, see U.S. Congress, Office of Technology Assessment, *Critical Connections: Communications for the Future*, OTA-CIT-407 (Washington, DC: U.S. Government Printing Office, in press).

limitations, and effective implementation will depend on matching technological capabilities to educational needs.

- **The technologies for accessing, storing, and manipulating information have more impact on the distance education experience than the technologies for transmitting signals.** Personal computers, display technologies, optical memory systems, facsimile (fax) machines, and graphics scanners expand the use of information and resources at distant locations.
- **Future developments in transmission, processing, and storage technologies promise even greater capabilities and benefits for education at the same or lower cost.** Advances in digital compression technology, for example, may greatly expand the number of channels that can be sent over any transmission medium, doubling or even tripling channel capacity. **Educational telecommunications systems may also enable new and different uses beyond the traditional school setting.** K-12 distance education systems can serve the needs of adult learners, continuing education at home or in the workplace, and the community.
- **The base of telecommunications infrastructure available for distance education is wide and expanding, giving schools an opportunity to utilize existing local resources and forge innovative partnerships.** Local, regional, and even State distance education efforts can be linked with telecommunications networks operated by colleges and universities, local businesses, public broadcasting stations, and State governments. Increasingly, the private sector, including the telephone and cable companies, are becoming active in helping schools expand their teaching and learning opportunities.
- Telecommunications policymaking and regulation is spread across several agencies and levels of government. There is no single focus of or direction to telecommunications policy that can help educators identify the problems and opportunities for educational telecommunications. **Regulatory uncertainties in the telecommunications field make planning for distance education difficult. Public policy changes in the regulation of the public telephone network, for example, will affect how distance education can be provided and how much it will cost.**
- Funding for distance education will compete with other education needs. Although technological capabilities continue to increase even as hardware costs decline, **the overall costs for distance education systems vary widely.** The cost of educational telecommunications systems will be determined in part by the number of sites, instructional demands, technical complexity, and distances involved. Initial equipment costs, while most visible, do not reflect the full costs of the system. Operational and programming costs may require substantial long-term financial commitments.

TECHNOLOGIES FOR DISTANCE EDUCATION

In the most fundamental sense, what distance learning systems try to do is to connect the teacher with the student when physical face-to-face interaction is not possible. **Just as highways move vehicles or pipes carry water, telecommunications systems carry instruction, moving information instead of people.** How these systems affect the educational setting/instructional process depends on the types of technology used and their design. **The technology at distant locations, including computers, videocassette recorders (VCRs), fax machines, television monitors and cameras, and even the telephone, are critically important.** Together, these technologies affect how interaction takes place, what information resources are used, and how effective a distance learning system is likely to be. Some systems allow simultaneous two-way audio and visual interaction plus an exchange of print materials. Other systems limit interaction to the one-way communication of voice, images, or data. Still others permit only delayed (asynchronous) interaction.

Audio

Live delivery of one-way audio programming is possible through the telephone system or a broadcast radio format.[2] In this format, the teacher speaks to the students, but they cannot respond directly. This lack of direct interaction is compensated for in some

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[2] Some developing countries using radio-based distance learning systems also deliver programming by mailing audiocassette tapes to schools that are too remote or geographically isolated to be reached by radio.

Photo credit: TI-IN

At the push of a button and the twist of a dial, students reach their distant teacher.

radio broadcast formats by a course design that requires students to "talk back" to the radio itself. Broadcast audio has been used extensively for student learning and teacher training in several developing countries, but, despite its extremely low cost, use in the United States has been very limited.[3]

Two-way audio allows both parties to talk and respond. (See figure 3-1.) This may be a simple two-way telephone link between a teacher and a homebound student or a "homework hotline," which students dial up to get special tutoring in specific subjects. The use of speaker phones at multiple sites connected by an audio bridging system allows a teacher and students to be connected and talk simultaneously—an extended "party line." Two-way communication can also take place asynchronously (not in "real time"). Voice mail systems

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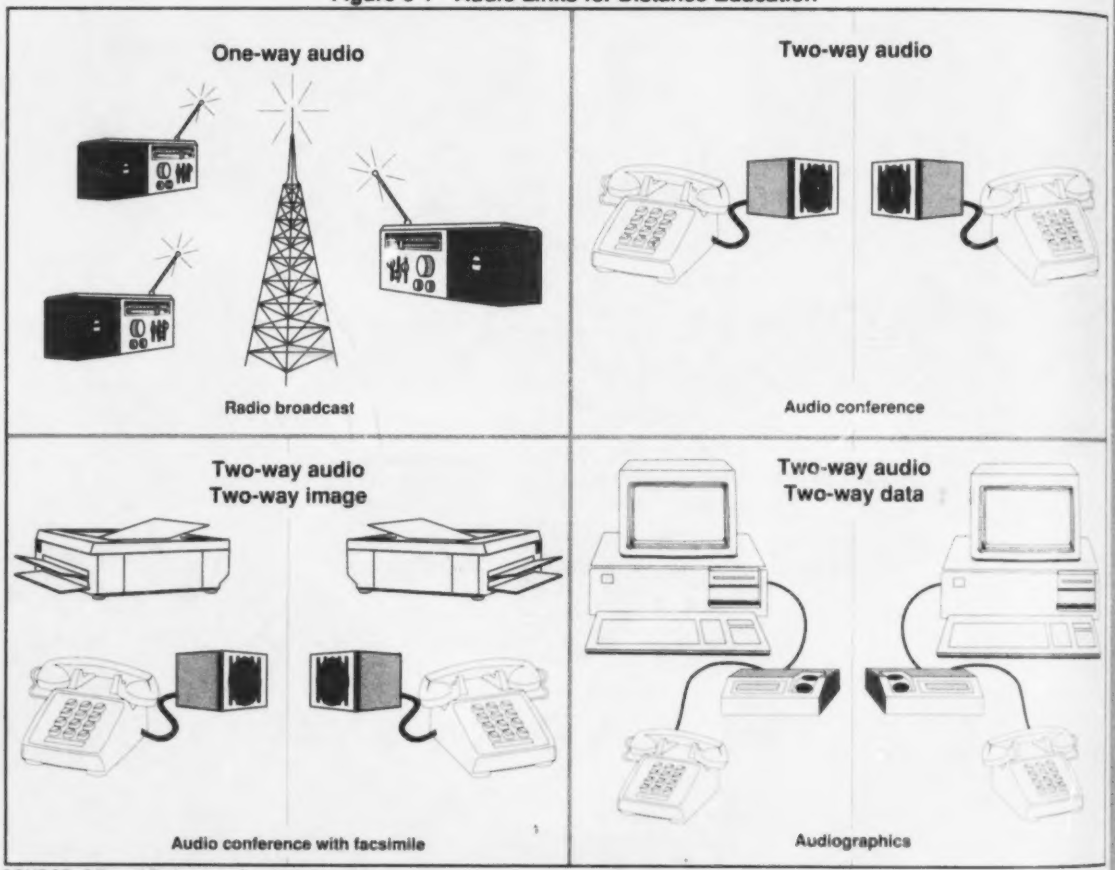
[3] For a discussion of various radio instruction projects in the developing countries, see U.S. Agency for International Development, Bureau for Science and Technology, *Development Communication Report*, 1988/Special Issue.

Figure 3-1—Audio Links for Distance Education



SOURCE: Office of Technology Assessment, 1989.

allow students to call-in questions that are recorded in their instructor's voice mailbox. The instructor can respond via voice mail or talk to the student personally. These voice mail systems often supplement other distance learning systems. If more immediate interaction is desired, materials can be sent by fax or other electronic means.

Video

The use of video communications, both one and two way, has increased dramatically in recent years. Factors behind this increase include: the growing availability of high bandwidth transmission paths over satellites and fiber optic links, the decreasing cost of such transmission, and the increasing ability to compress video signals.[4]

There are several formats for transmitting video. Full-motion video signals can be transmitted on television broadcast frequencies, on satellite circuits, over coaxial cable, and over fiber optic lines. Limited-motion or compressed video uses digital technology to reduce the amount of information it takes to send a video signal, making the programming cheaper to send. These signals may appear "smeared" or blurred, but quality is generally good enough for applications where motion is limited.

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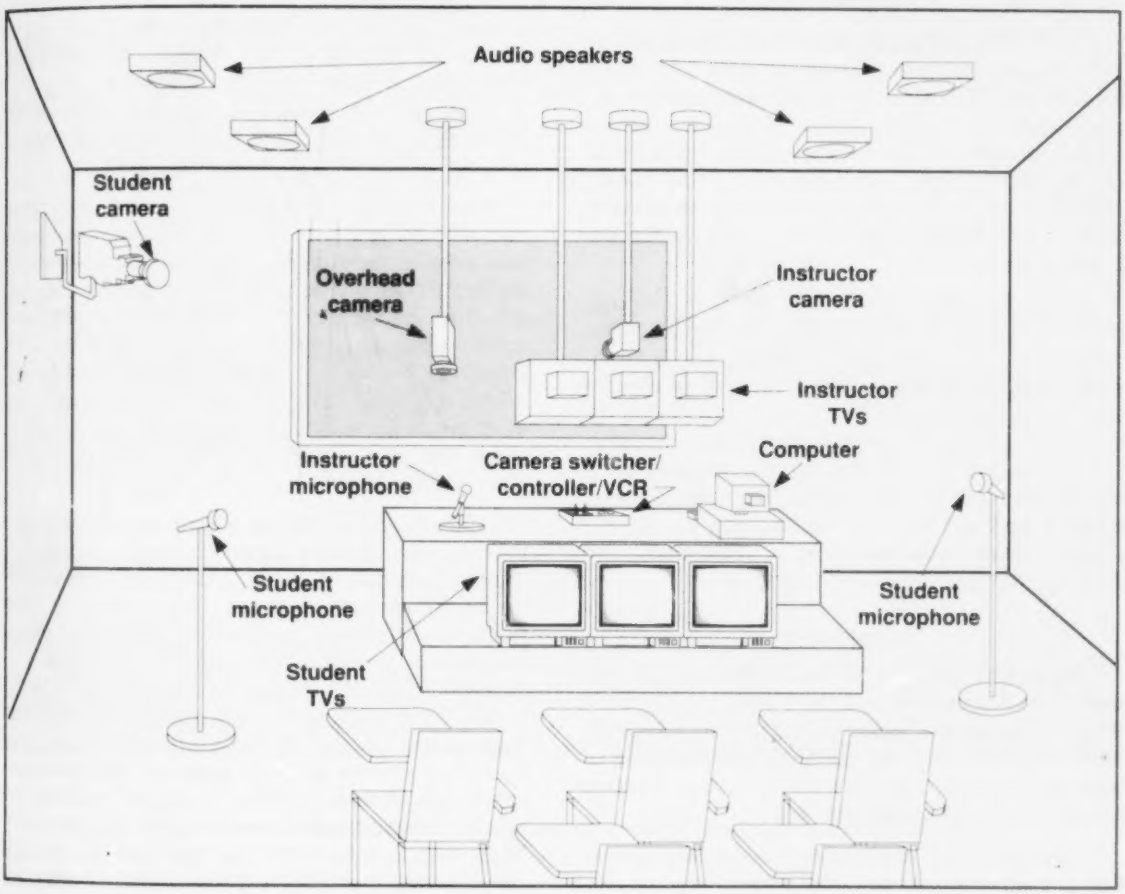
[4] Advances in compression technology are being made very rapidly. Rates as low as 56 kilobits per second (kbps) are being developed that will transmit video signals. The improvement in quality at lower speeds is also noticeable; images transmitted at 1.544 Mbps are much clearer than those of only 1 or 2 years ago. Rob Stoddard, "Compression's Catching On," *Satellite Communications*, vol. 13, No. 4, April 1989, pp. 31-33. The downside to compression is that the equipment necessary for digital-analog conversion can be expensive, costing up to $60,000. With one codec needed at each end of a transmission line, like a computer modem, total costs can rise quickly in a digital video system with many sites.

Figure 3-2—Two-way Interactive Instructional Classroom


Audio speakers
Student camera
Overhead camera
Instructor camera
Instructor TVs
Computer
Instructor microphone
Camera switcher/ controller/VCR
Student microphone
Student microphone
Student TVs

This two-way interactive classroom can function as either a sending or receiving site.

SOURCE: Tele-Systems Associates, Inc., 1989.

Compressed video signals can be used on all types of transmission systems except basic telephone lines. For digital video transmission over the public telephone network, special digital lines may be required. The only type of video standard telephone lines can transmit presently is a slow scan or freeze frame image, such as those used in videophone applications, in which a still image is sent approximately every 30 seconds. In the future, high definition television (HDTV) may be used in education. However, standards for HDTV transmission and production are not set, and the development of HDTV remains uncertain.

One-way educational programming is broadcast (point-to-multipoint) via satellite, ITFS, cable television, or public broadcasting systems. In interactive telecourses, one-way video is supplemented by two-way audio, allowing students to ask questions or respond to the teacher in real time. In some systems, a one-way data/text transmission is broadcast along with the video, allowing the student to receive printed material such as homework assignments, handouts, and quizzes.

The VCR extends the use of live instruction by allowing students and teachers to record materials for later use. Teachers can record programming for use in their own lesson plans. Students can record classes, allowing them to "attend class" when it is convenient for them. This capability also allows students to replay sections they did not understand the first time through—in essence asking the teacher to repeat a missed point.

Two-way video allows full audio and visual communication between teacher and student. Because two-way video systems take so much bandwidth to transmit, they generally operate as closed-circuit systems using fiber optic, coaxial cable, or microwave links. These systems are usually local, and involve a limited number of sites. Students at the remote sites can see the teacher, and depending on system configuration, the teacher can see all the students either simultaneously, or sequentially, by switching among sites. (See figure 3-2.)

Computer

Computers in today's classrooms can also be used for distance learning. Personal computers (PCs) can communicate and share information with other PCs or mainframe computers in real time or with some delay (asynchronously) using modems and the public telephone network.[5]

Computer-based applications in distance education can serve as a stand-alone system, e.g., audiographics or computer conferencing, or as a supplement to another system, such as videoconferencing. Computers can also be used by students before and after class either to prepare lesson materials for their distance learning class, or to engage in other learning activities (such as computer-assisted instruction).

Computers linked to remote databases or bulletin board services (BBS) provide students and teachers with access to a wide variety of information and resources. Through a BBS, teachers can keep in touch with colleagues or take professional development classes. Students can "talk" to each other, share data, or receive instruction. On-line courses allow students at home or in computer centers to access coursework day or night. Students work on group projects collaboratively over time (asynchronously) and leave messages in personal electronic mailboxes. Messages can be left 24 hours a day, 365 days a year; users can "go to school" at their own convenience.

With special communications software, teacher and students can communicate in real time using their computers. More advanced software allows the teacher's computer to control the students' computers, allowing the group to see and work on the same screen (text or graphics) at the same time. This function, known as "electronic blackboarding," allows a teacher to reach a homebound student, for example. If more than two sites are to participate in the lesson, a telecommunications bridge linking all users simultaneously would be required.

Computer-based distance learning delivery systems can be expanded in several ways. To enhance input capabilities, scanners and graphics tablets can be added. A scanner allows the teacher to send graphics or drawings prepared on paper. The image can also be stored in the computer until needed. A graphics tablet allows teacher and students to write or draw electronically—on a special digitized pad with a special pen—just as on a piece of paper. The computer screens in both locations become electronic blackboards. Adding a printer enables the teacher to send handouts or homework assignments. With special software, a fax machine can provide input to the PC as well as allow the PC to originate fax transmissions.

The most advanced form of computer networking, audiographics, augments computer interaction with real-time audio communication. Not only can the participants communicate with each other via their computers, they can also talk to each other at the same time. Audiographics systems have traditionally required the use of two telephone lines, one for the audio connection and another for the computer/data connection. Systems now in use can combine the two lines onto one phone line.[6]

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[5] There are currently more than 6,000 schools (7 percent) with modems. U.S. Congress, Office of Technology Assessment, *Power On! New Tools for Teaching and Learning*, OTA-SET-379 (Washington, DC: U.S. Government Printing Office, September 1988), p. 192, footnote 11.

[6] A special modem combines the two signals so that they can be sent over the same line, thus cutting line costs in half. The most advanced systems also have a "screen grabber" capability, allowing color video images such as photographs to be electronically captured, transmitted, and annotated. An instructor teaching electronics, for example, could scan in an image of a circuit board which could then be annotated by the teacher to point out the various components.

Photo credit: Optel Communications, Inc.

Audiographics systems combine the power of the computer with the personal touch of a telephone conversation.

In the future, more powerful computers, an improved public telephone network, and a wider array of peripherals promise to bring even more capabilities and features to computer users and distant learners alike. Advances in graphics manipulation and storage are one area of rapid advance.[7] Technologies such as digital video-interactive (DV-I) and compact disc-read only memory (CD-ROM) are bringing full motion video display and editing capability to desktop computers, while advances in HDTV promise even clearer images and graphics.

Supplemental Technologies

Almost any of the systems described previously can be supplemented by other technologies to provide more features and capabilities. Figure 3-3 shows some of these technologies used in the Kentucky Educational Television system.

Generally, the exchange of hard copy is the "weak link" in any distance learning system. Many districts use courier services or the U.S. Postal Service, but these can be slow and/or expensive as well as unreliable. Other methods of delivering hard copy include: transmission of data in satellite sidebands or in the Vertical Blanking Interval (VBI) of the television signal, by fax, or by converting data to standard television signals. In these cases, special equipment such as data controllers may be needed to receive and print out the material.

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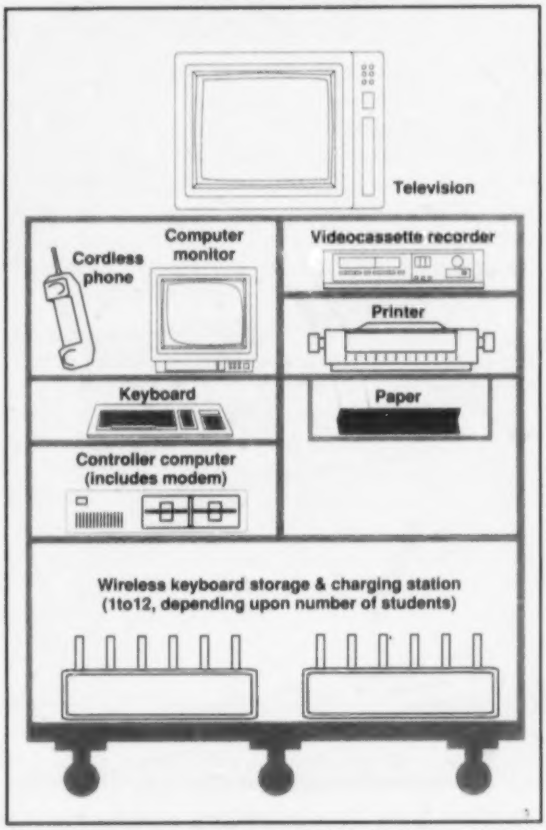
[7] John W. Veritz and Corie Brown, "The Graphics Revolution: A Special Report," *Business Week*, No. 3081, Nov. 28, 1988, pp. 142-153.

Figure 3-3—Classroom Equipment for Distance Learning


Television
Cordless phone
Computer monitor
Videocassette recorder
Printer
Keyboard
Paper
Controller computer (includes modem)
Wireless keyboard storage & charging station (1to12, depending upon number of students)

Many different technologies are used in the distance learning classroom. Often, equipment is placed together on a movable cart that can be rolled from class to class as needed.

SOURCE: Kentucky Educational Television, 1989.

Storage and other information technologies enhance educational material delivered electronically. The VCR allows students and teachers to tape live or prerecorded educational programming for later use. Optical discs combine audio, full-motion and still video, and data on one disc. They are known by various names including: CD-ROM, DV-I, and compact disc-interactive (CD-I).[8] Consumer applications of such technology already allow disc players to read both computer CD-ROMs and compact audio discs.

To increase the amount of interaction between student and teacher, many satellite-delivered programs now use student feedback devices. These devices, such as the keypads piloted by Kentucky Educational Television, allow students to respond directly to questions posed by the remote teacher. Responses are transmitted to the remote teacher, tabulated by a computer, and displayed almost immediately, allowing the teacher to respond quickly to student feedback. Such systems allow teachers to better judge how well remote students understand the material being presented.

TRANSMISSION TECHNOLOGIES

Transmission technologies also play an important role in the delivery of distance education. There are many ways to transmit a signal between two points, and users may not know (or care) how a signal is being transmitted—by copper wire, optical fiber, satellite, or microwave. **Each technology has capabilities and limitations that constrain the distance learning system, shaping the educational product. (See table 3-1.)** Satellite systems and other broadcast technologies, for example, do not generally allow the teacher to see the students, a critical concern for many educators. Other concerns facing educators as they contemplate distance learning delivery systems include regulatory requirements, availability of local infrastructure resources, and possible technical and economic trends that may affect these transmission technologies. The following section addresses these areas as they affect each delivery system. Sample costs for the technologies can be found in appendix B.

Broadcast Technologies

Broadcast television signals consist of audio and video channels transmitted from a central point that can be received by anyone within range of the transmitter. Television broadcasting requires expensive transmission equipment as well as a large tower from which to transmit the signal. Viewers, however, need only a standard television set to receive the signal; no special conversion is required. Geography is a barrier in mountainous regions where reception may be poor, but line of sight is generally not required. Most educational programming broadcast over television does not allow real-time interaction with the television teacher, but interactivity can be designed into live or recorded telecourses in

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[8] DV-I and CD-I are similar in concept, but DV-I operates through a personal computer, while CD-I works through a videodisc player connected a standard television set.

Table 3-1—Transmission Technologies for Learning at a Distance

Technology[a]	Configuration	Advantages	Disadvantages	Trends
Terrestrial broadcast	One-way broadcast of audio, video, and possibly data; possible audio return	No special receiving equipment or converters; reaches most schools and homes	Limited channels and air time; reception limited by geography; high transmission equipment and production costs	Increased use of data/text transmission
Fiber optic	Two-way audio, data, and video	High capacity/speed; channel capacity easily expandable; high-quality signal	High installation cost; rights-of-way may be required to lay new cable	Costs are declining rapidly; fiber deployment is expanding rapidly
Microwave	Two-way point-to-point audio, data, and video	Low-cost transmission time; no rights-of-way needed	Must be FCC-licensed; tower space or location may be difficult to get; difficult and costly to expand channels; crowded frequencies; line of sight required	Use of higher frequencies is expanding
Instructional Television Fixed Service (ITFS)	One-way broadcast or point-to-point audio, data, and video; possibility of audio return	Low-cost delivery of video	Crowded frequencies, especially in cities; FCC licensing required; limited transmission range; line of sight required	Digitalization may triple channel capacity; wider coverage areas using repeaters; rebroadcast of satellite-delivered programming
Public Switched Telephone Network (PSTN)	Two-way voice; limited data and video	Wide coverage; low initial cost; high quality and capacity of fiber optic links; others handle repair and upgrades	Quality is spotty; limited transmission of data and video; cost is distance-sensitive	Expanding fiber installation; digitization of network increasing; increasing intelligence in the network
Satellite	One-way broadcast of voice, data, and video; possibility of audio and data return	Wide coverage transmission cost is distance insensitive	Expensive uplinks; high transmission costs; FCC licensing of uplinks; receive site microwave interference (C-band) or rain fade (Ku-band)	More use of Ku-band; possible transponder shortage; increased use of data; increased interactive capabilities
Audiographics	Two-way computer conferencing with audio interaction	Low cost; easy exchange of graphics; uses PSTN	Visual interaction limited to graphics/still video	More powerful computers; better software and peripherals increase capabilities
Cable television systems	One-way broadcast or two-way point-to-point audio, data, and video	Wide availability; low delivery costs	Limited capacity; can be difficult to interconnect; not usually designed for interactivity	Capacity increases using fiber; more addressability and two-way capability

[a] Technology systems do not have to operate independently; they are often combined in "hybrid" systems.

SOURCE: Office of Technology Assessment, 1989.

variety of ways, including using the telephone to link students to teachers or aides or using the VCR interactively.

In addition to the video signal, television broadcast signals can send text and data simultaneously. The Public Broadcasting Service (PBS) recently demonstrated potential uses of the VBI, the unused portion of the television channel (the black band in the television picture), as part of its Educational Pipeline project. PBS plans to use the VBI to deliver student and teacher guides and support materials, program information, and computer software, including complete interactive computer-based courses. Another system allows data to be transmitted as a standard broadcast signal. The system could be likened to a video modem.[9] Data can be sent either before or after a telecourse has been delivered, but cannot be sent simultaneously. This system is useful for transmitting teacher's guides or any other print-based materials.

Low power television (LPTV) may also have a role to play in the delivery of distance education. These stations operate on normal television frequencies, but at a much lower power level. This limits their effective range to 20 miles at most. The advantage of LPTV over conventional broadcast is the much reduced cost of operation.

Radio broadcasting has been used extensively in other countries to deliver education and inservice training, but its use has been very limited in the United States.[10]

Instructional Television Fixed Service

ITFS refers to a band of microwave frequencies originally set aside by the Federal Communications Commission (FCC) in 1963 exclusively for the transmission of educational and cultural programming. There are 20 channels assigned to ITFS, down from the 31 originally allocated in 1963. These channels are usually grouped in blocks of four per licensee. In 1983, there were 88 ITFS systems operating 644 channels;[11] in 1989, that figure rose to 745 licenses to operate 2,358 channels.[12] In the last year, applications have increased dramatically, with more and more applications coming from rural areas.[13] Twenty-two of the Nation's 338 public television stations use ITFS to deliver instructional programming.

ITFS uses omnidirectional microwave signals in the 2.5 GHz band to transmit standard 6 MHz video signals to remote locations. (See figure 3-4.) In addition to the main video channel, there are two subchannels per main channel capable of carrying audio, data, and still pictures. ITFS usually functions as a broadcast (point-to-multipoint) television system, except that a special downconverter is needed to convert the microwave signal to a standard television signal. The normal range of ITFS transmissions is approximately 20 miles, although range can be increased by using signal repeaters, by increasing the height of transmitting and/or receiving antennas, by increasing receiver sensitivity, or by increasing transmitter power.[14] These options may add substantially to initial system costs. Like point-to-point microwave, ITFS requires direct line-of-sight to operate; receiving antennas must be precisely aligned to receive the signal. Areas subject to high winds or intense storms, for example, may require sturdy, and more costly, towers.

An ITFS network can serve as a stand-alone distance education delivery system, transmitting locally originated programming directly to local schools or cable companies for redistribution through their network. ITFS may also function as an intermediate link, taking a signal from a satellite feed, for example, and rebroadcasting it to local subscribers. Most commonly, ITFS is used to deliver one-way video to schools with telephone hookups for two-way audio. Two-way video is possible using

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[9] Computer data is fed into the modem, which converts it to standard video. The signal is then transmitted as any ordinary television signal. The information received is converted by the modem back into digital data and routed into a computer, where it is then available for viewing and printing. The data signal rides in the primary video channel of the broadcast signal (not in the vertical blanking interval or on a sideband), and appears as a series of boxes on the television screen.

[10] See, for example, U.S. Agency for International Development, op. cit., footnote 3.

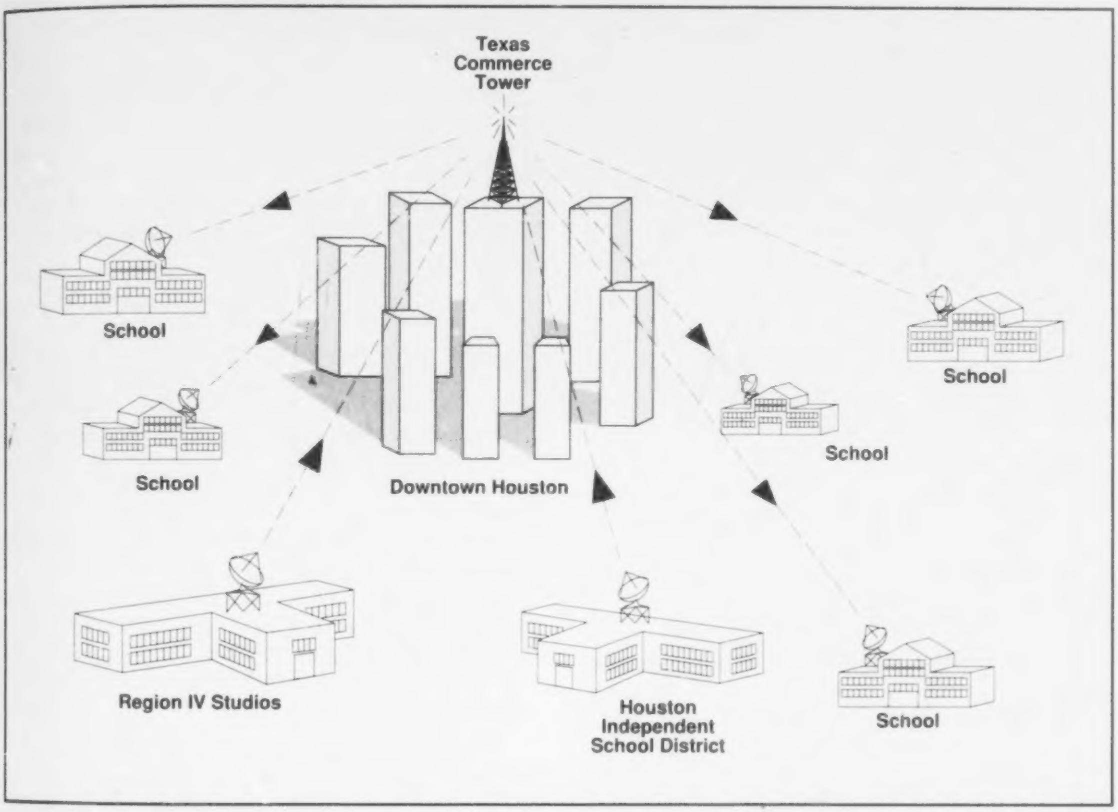
[11] Sally L. Bond, *Telecommunications-Based Distance Learning: A Guide for Local Educators* (Research Triangle Park, NC: Southeastern Educational Improvement Laboratory, spring 1987), p. 30.

[12] George Fehlner, FCC ITFS division, personal communication, Apr. 4, 1989.

[13] Ibid.

[14] For example, with a high-powered (50 watts) transmitter, distances of 50+ miles are achievable. At 20 miles, a 2-foot parabolic dish can be used for reception. For longer distances, larger receiving dishes are needed (the limit without regeneration appears to be 50 miles with a 10-foot receiving dish). Some fading can occur if the signal travels over large bodies of water.

Figure 3-4—The InterAct Instructional Television Network



Seven channels of programming originate from the Region IV studios; one channel comes from Houston Independent School District. Thirty-seven districts subscribe to the network and 300 schools receive programming.

SOURCE: InterAct Instructional Television Network, Region IV Education Service Center, Houston, TX

ITFS (or point-to-point microwave) to transmit back from the remote schools. However, this greatly increases the cost of the system, and requires double the number of channels for a given number of sites. Along with the 20 audio/video channels, there are also 20 corresponding audio channels located together at the high end of the ITFS frequency band that can provide audio feedback from receiving sites. These channels are not used by most systems because regular telephone lines can be used for the same purpose. If telephone connections are long distance, ITFS talk-back may be more cost-effective in the long term. Two-way audio capability requires additional electronics (transmitter, multiplexer, and possibly a new antenna) at each receive site.

Data or text can be sent over an ITFS system in many ways. Data/text sent simultaneously with video programming is possible using the VBI or subchannels. The "video modem" allows data/text to be sent either before or after a broadcast.[15] Any of these methods require the use of additional equipment to convert data for transmission as well as equipment to decode the data once it is received. This equipment enhances system capabilities, but also increases system costs.

Digital technology and compression techniques may increase ITFS channel capacity so that three compressed video signals could be transmitted on each ITFS channel. However, the equipment needed to compress and decompress these digital video signals is still very expensive, and the technology has not yet been demonstrated.[16]

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[15] See footnote 9.

Regulation

FCC and sometimes Federal Aviation Administration (FAA) approval and licensing are required to operate an ITFS system.[17] FCC approval can take as long as 2 years. FCC requires and reviews an engineering analysis of each proposed system. One problem identified by FCC has been the varying quality of the applications.[18] In some cases, FCC must do its own analysis; adding even more time to the process. FCC review of how the system will actually be used has become more stringent as competition for ITFS frequencies has increased.

Siting and zoning requirements in local communities may conflict with tower placement or height. Schools may find that towers cannot be situated on school grounds or that the height required for adequate reception is too high for local regulations.

Issues and Future Implications

ITFS channels are saturated in many locations, especially metropolitan areas. Educators considering an ITFS system, especially at the K-12 level, may find that channels have already been licensed to higher education institutions or PBS stations. Many ITFS channels are not used by educational institutions, but have been leased to Multipoint Distribution Services (MDS) operators, who use the channels to offer premium entertainment channels (such as HBO) and data transmission services. FCC does not monitor how many channels are leased, but has established safeguards to ensure that channels are used for education (at least 20 hours per channel per week) and that time can be "recaptured" from commercial operators if educational needs increase. The amount of time recaptured by original educational licensees is also unknown, but is thought to be very small.[19]

Because the range of ITFS is limited to 20 miles and requires line-of-sight, ITFS is best suited to local or regional applications. However, the scope and range of an ITFS system can be extended through connection(s) to such long distance transmission systems as fiber optic backbones or satellite.

Satellite

Satellites function as relay stations in the sky. A communication signal is sent from an Earth station (called an uplink) to the satellite, which then retransmits the signal back to Earth, where it is received by a satellite receiver (downlink).[20] Satellites are normally used to transmit audio, data, and video programming in a point-to-multipoint configuration.[21] (See figure 3-5.) Like other broadcast technologies, the signal from a satellite can be received by any dish in the satellite's coverage area pointed at that satellite and tuned to the appropriate channel (transponder).[22] Some channels, however, are scrambled, requiring a descrambler to receive the signal.

Two types of satellites orbit the Earth. Geosynchronous satellites maintain a constant relative position in the sky, meaning that they can always be "seen" by receiving dishes. Other satellites called low-altitude satellites orbit the Earth at lower altitudes than the geosynchronous satellites, and cannot maintain a constant position above the Earth. This means that they are only accessible when they come into view of the receiving dish, two or three times a day, and then only for a few minutes at a time. These low-altitude satellites are generally smaller and cheaper than geosynchronous satellites.

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[16] Federal Communications Commission regulations governing Instructional Television Fixed Service (ITFS) are currently based on analog technology. These regulations would probably have to be rewritten to accommodate digital transmission on ITFS channels.

[17] FAA approval may be required for tall towers that may interfere with low flying planes.

[18] Fehlner, op. cit., footnote 12.

[19] Ibid.

[20] There are many terms for satellite receive devices, including dish, antenna, television receive only (TVRO), terminal, and downlink.

[21] In addition to the main (wideband) video channels sent, there are also narrow bandwidth subcarriers that can be used to send audio or data signals to remote sites. Missouri's Educational Satellite Network system plans to use subcarrier transmission of data to printers at each school, while TI-IN uses the Horizontal Blanking Interval of the video signal for data transmission. Other methods for transmitting data and text include using the Vertical Blanking Interval in standard video transmissions and the video modem system described in the Broadcasting section. Such systems allow the program originator to send teachers guides, written homework assignments, and questionnaires to all receive sites.

[22] The area in which a particular satellite can be received is called that satellite's "footprint." Satellites, which can be received all over the continental United States, provide full "conus" coverage. Receive sites located at the very edges of the footprint require much larger dishes than those in the middle of the coverage area because the signal gets weaker towards the edges of coverage.

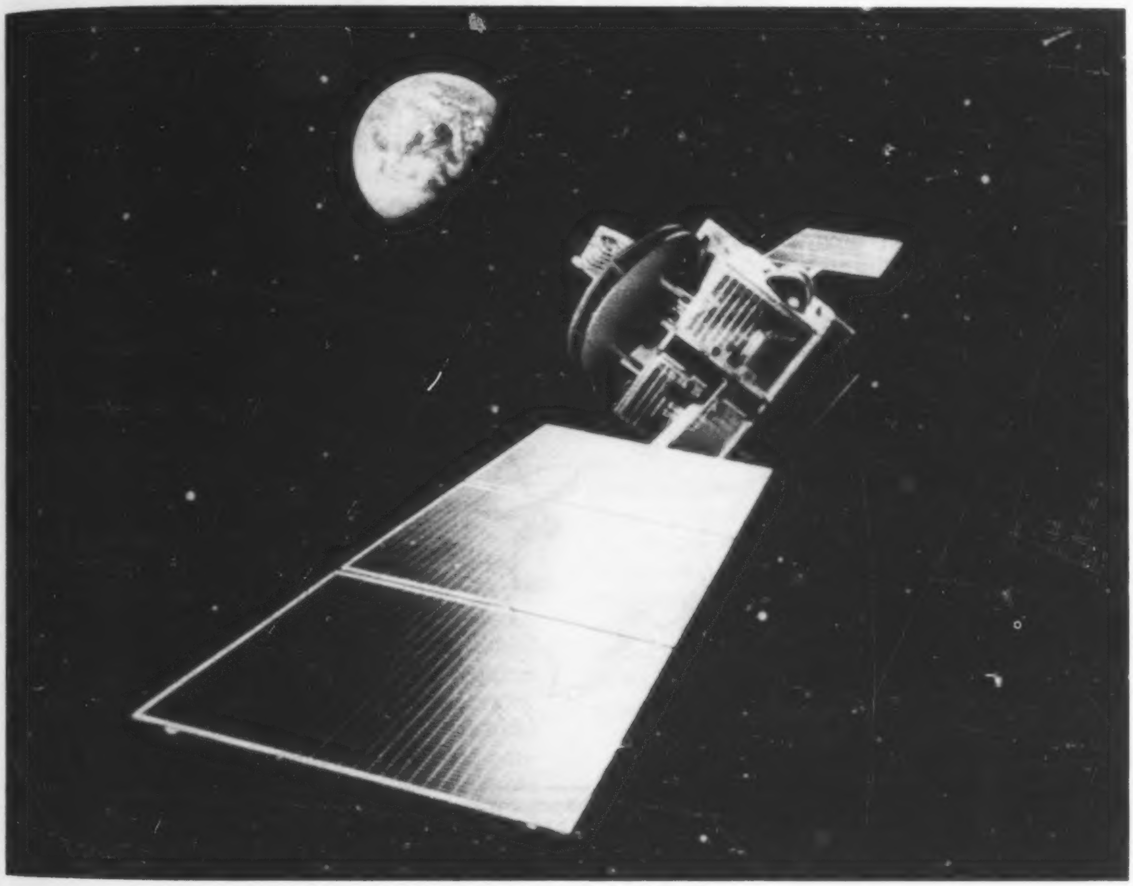


Photo credit: GTE Spacenet

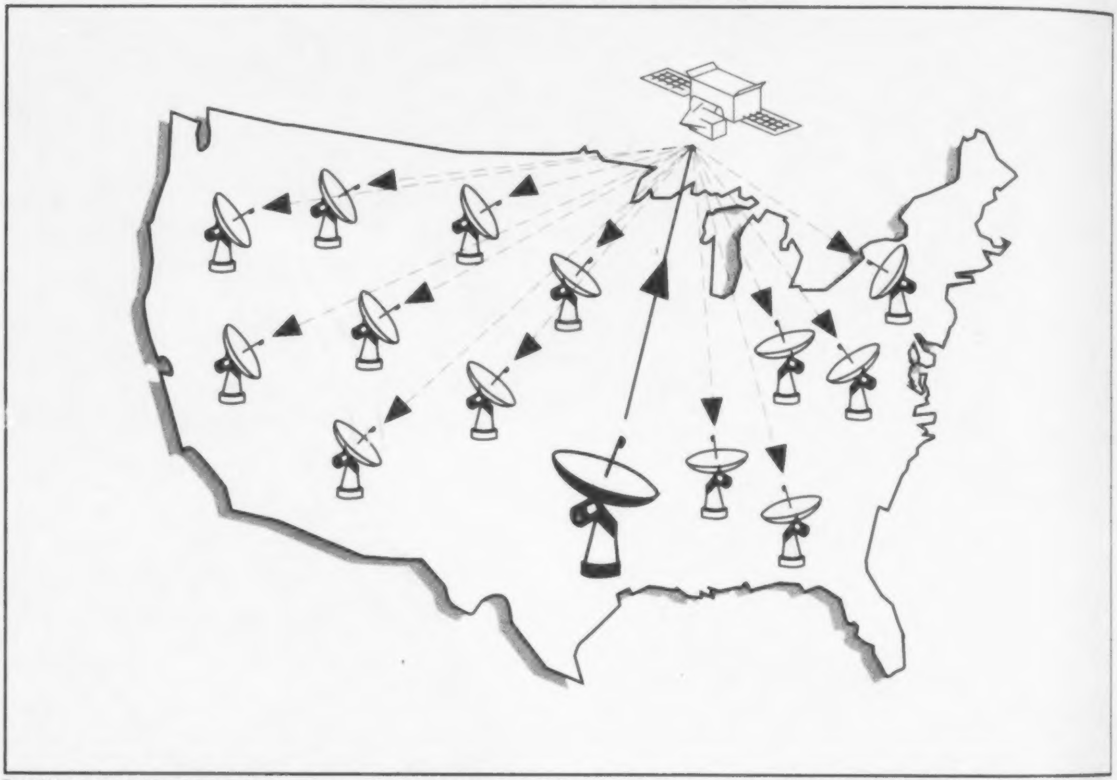
From 22,300 miles above the Earth, satellites can transmit phone conversations, video programming, and data communications around the world.

and may lend themselves well to "store and forward" applications such as computer conferencing or voice mail in which immediate interaction is not required.

Satellite transponders receive signals from the uplink and transmit them back to Earth. Satellites typically have between 12 and 24 transponders that operate in two frequency bands: C-band and Ku-band. C-band satellites are the oldest and most common type of system in use today. They use a signal operating at 6 GHz for the uplink and 4 GHz for the downlink (6/4). Receiving dishes are usually large (3.2 to 10 meters), making them somewhat expensive and difficult to install. C-band reception is subject to interference from terrestrial microwave facilities, but interference from rain is not a problem as with higher frequency (Ku-band) satellites.

Ku-band satellites operate at 14/12 GHz, and use smaller (3 meters or less) dishes that are cheaper and easier to install than C-band dishes. Ku-band frequencies are not shared with terrestrial microwave facilities as are C-band, reducing potential interference. Ku-band, however, is much more subject to transmission problems caused by precipitation. Because of its lower cost and smaller dish size, Ku has become the most popular band for many satellite

Figure 3-5—Satellite Communication System



Satellites can deliver educational programming and courses to schools across the country. Video programming and text materials are broadcast from a central origination site (uplink) to any school with a satellite receiver (downlink).
SOURCE: Office of Technology Assessment, 1989

program providers, especially in business, and an increasing percentage of future satellites will be Ku-band or Ku/C-band combinations.[23]

The deployment of Ku-band satellites has also led to the development of new receivers called Very Small Aperture Terminals (VSATs). VSATs are small (1.8 to 2.4 meters), easy to install, and basic models are relatively inexpensive. They are used primarily for data communication, but can be upgraded to provide interactive audio and video services. Adding such services, however, greatly increases cost. VSATs cannot usually communicate with each other directly; they can only send and receive signals to and from a central site (known as a "hub"). In order to connect remote sites, a signal must be transmitted to the hub, which then rebroadcasts it to the receiving site.

Direct broadcast satellites (DBS) are high-powered satellites that transmit programming directly to the general public. Receive dishes used in DBS systems are very small (1 meter). DBS could allow programmers to beam educational programming directly to homebound students, providing an alternative to over-the-air broadcasting or cable hookups. Although no such services are operating in the United States,[24] a DBS education service serving European schools plans to begin operation in October 1989.[25]

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[23] There is, however, a large installed base of C-band transmitters and receivers, and C-band satellites are expected to be used extensively, especially by the cable television industry, for many years to come.

Ka-band satellite technology is the most advanced satellite technology being developed, but no Ka satellites will be operational until the early to mid-1990s. Ka-band satellites will use frequencies in the 30/20 GHz band, allowing them to transmit much more information. Ka-band receive dishes are expected to be smaller (1 meter in diameter), cheaper, and easier to install than today's Ku dishes. The National Aeronautics and Space Administration's Advanced Communications Technology Satellite, scheduled for deployment in the early 1990s, will be Ka-band. Ka-band satellites, using on-board switching and narrower transmission beams, may eventually enable direct point-to-point (school-to-school) communication.

Regulation

FCC regulation of satellite communication most directly affects satellite uplink operation. Every C-band uplink must be licensed due to potential interference with adjacent satellites and terrestrial microwave sources. The licensing process requires careful frequency coordination, a sometimes lengthy process. It is much easier to license Ku-band uplinks because there are no terrestrial interference concerns. Regulations regarding satellite downlinks are not hard to satisfy. Downlinks need not be licensed at all for Ku-band receivers and for C-band receivers only when the user wants to protect against possible future interference.

Issues and Future Implications

The number of schools with satellite dishes is growing rapidly. The number of dishes installed in schools has doubled since last year. Data from the 1988-89 school year indicates that approximately 7 percent of school districts had satellite dishes: 68 percent of those districts have C-band dishes, 40 percent have Ku-band dishes, and 7 percent have dual-band dishes capable of receiving both C- and Ku-band; 84 percent of dishes owned by school districts are steerable.[26]

The amount and variety of programming a school can receive depend on many factors. Schools wanting to receive many different satellite programs must be able to access different satellites; use different frequency bands; decode different audio, video, and data formats; and adapt to different scheduling times. Schools have fewer programming choices if they have a fixed dish aimed at only one satellite as opposed to a steerable dish, which may be reaimed to receive other signals. While increased access is an advantage, the higher costs and sometimes lower performance of a steerable dish may prove to be substantial barriers. The type of dish (C or Ku) also limits programming possibilities. Satellite dishes can usually only receive one band of transmission. Dishes that can receive both C and Ku are more expensive than single band dishes. The trend in the satellite industry toward Ku-band satellites may also pose problems for schools;[27] it may be difficult or impossible to upgrade from C to Ku without buying a new dish.

Access to programming also depends on receiving electronics. Some receivers, especially at Ku-band, are preset to receive signals from a certain satellite (or certain transponders on a certain satellite); even if a school has a steerable dish, it may not be very useful in accessing other satellites.

A shortage of satellite capacity (both C- and Ku-band) may develop. Demand for satellite services has increased rapidly, especially in the business sector with the proliferation of VSAT networks.[28] The generation of satellites currently in orbit, however, is due to be retired in the early 1990s.[29]

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[24] The Public Service Satellite Consortium (PSSC), in conjunction with Advanced Communications Corp., an FCC-licensed DBS operator, had planned to offer a dedicated educational channel called "Your Educational Service." It was to provide educational programming directly into schools, especially rural schools. Unfortunately, plans fell through due to a lack of funds. PSSC is continuing talks with satellite suppliers in the hope of using another satellite. Suzanne Douglas, Public Service Satellite Consortium, personal communication, Apr. 3, 1989.

[25] "Eurostep To Offer Europe-wide Classes," *Satellite Communications*, vol. 13, No. 6, June 1989, p. 15.

[26] PBS Elementary/Secondary Service, *The PBS School Satellite Survey* (Alexandria, VA: Public Broadcasting Service, July 1989). In addition, PBS estimates that more than 1,200 institutions of higher education have satellite downlinks.

[27] Much of the commercial programming now available to schools is on C-band, but many program providers, especially in the business arena, are switching to Ku-band because there is less terrestrial interference and because receive dishes are smaller and less expensive.

[28] Tom Kerver, "Good Ideas To Pay Off in '89," *Satellite Communications*, vol. 13, No. 1, January 1989, p. 15.

[29] Ibid.

Nineteen satellites have been authorized by FCC (10 are replacements); these satellites are not expected to be operational for 4 to 5 years. In the meantime, demand may outstrip supply of satellite capacity, possibly forcing up the transponder fees satellite program providers pay. More seriously, if a shortage were to develop, occasional users could be bumped off the satellites in favor of full-time users willing to pay premium prices. Educational providers (universities, consortia, regional school districts) would have to lease their own transponders or cooperate with those who do have access.

Technical developments may ease any potential shortage. Ku-band transponders can be "split," doubling the number of channels that can be transmitted.[30] This allows a provider to add additional programming without buying extra transponder time.[31] Several educational programming providers, including the National Technological University and TI-IN, use split transponder techniques. Another technique for maximizing transponder capacity is to use digital compression. Systems under development may allow up to 18 full-motion video channels to be transmitted over one transponder.

Cable Systems

Cable television systems use coaxial and fiber optic cable to distribute entertainment and other services to local subscribers. (See figure 3-6.) Programming is received from local broadcast stations and national programming services, such as HBO, at the cable "headend" and is sent out over the cable in a tree configuration. A cable headend can receive many types of signals, such as satellite or microwave transmissions, which can then be retransmitted to the schools over the normal cable system. The reach or scope of the system depends on the size of the franchise area and interconnections with other companies. A cable franchise area does not necessarily follow the same boundaries as local school districts, and in some areas, different schools or districts may be served by different cable companies. Cable systems vary greatly in size, often depending on the age of the system.[32] In addition to the actual cable, the equipment required includes: modulators, demodulators, addressable convertors (for certain programs such as pay-per-view), and amplifiers. The life expectancy of this equipment is approximately 10 years.

Cable television systems are primarily one-way, broadcast (point-to-multipoint) type systems. Many systems also have a limited number of reverse channels that can give some measure of two-way interactivity to the system. The number of reverse channels depends on the design of the system. They are most commonly used for data transmission or ordering pay-per-view services, but are capable of transmitting video signals.[33] A school could be assigned its own reverse channel to allow it to transmit information back "upstream" to the cable headend. Most cable systems make only limited use of this two-way capability, because additional (reverse flow) amplifiers are needed to move signals upstream, as well as special filters to keep upstream and downstream signals separate. Additional equipment also requires increased maintenance.

Most (two-way) cable systems have limited switching ability; that is, they cannot directly connect point-to-point. Instead, signals from the schools are sent back to the headend via reverse channels, and then retransmitted over a standard (perhaps scrambled) downstream channel. Anyone on the system can receive the signal (in addition to the intended site) by simply tuning in that channel. Some newer cable systems use addressable decoders connected to the television set that restrict nonpaying television subscribers, and allow specific programming, such as pay-per-view services, to be received. Some systems, such as the University of Lowell's cable system (see figure 3-7), do have some switching ability, but this system is a dedicated institutional network separate from the public cable system.

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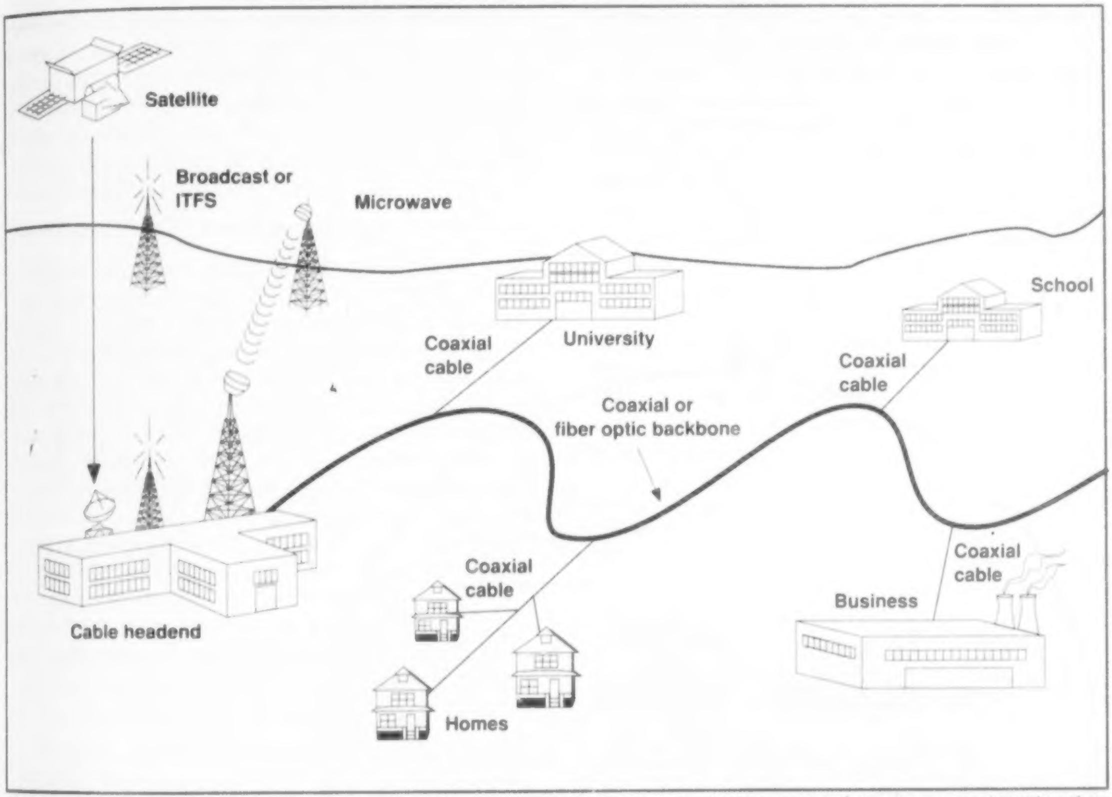
[30] Because most C-band transponders do not have enough bandwidth (36 MHz), this technique is not available to them.

[31] There is a trade-off between dish size and cost. If the signals interfere with each other, power can be reduced to lessen the interference, but larger and more expensive dishes may then be needed to receive the signal.

[32] Cable systems are limited by the number of times a signal must be amplified to reach a subscriber. Each time the signal is amplified, more noise is introduced into the signal, and after 20 to 30 amplifications, picture quality becomes unacceptable. New developments in fiber optic technology are extending distances between amplifiers and improving signal quality.

[33] An innovative project in Sibley County, MN, found another way to increase interaction by connecting fax machines over the cable television lines. The benefits realized include greater speed, no telephone charges (new dedicated lines and long distance charges), and simultaneous broadcast capability (most fax is broadcast sequentially). David Czech, "Fax, TV and the Remote Classroom," *T.H.E. Journal*, vol. 16, No. 8, April 1989, pp. 69-72.

Figure 3-6—Cable Television Distribution System



Programming from many sources can be redistributed through a cable television distribution system. Schools can receive educational programming through the local cable company and some systems can also be used for two-way communication between schools.

SOURCE: Office of Technology Assessment, 1989.

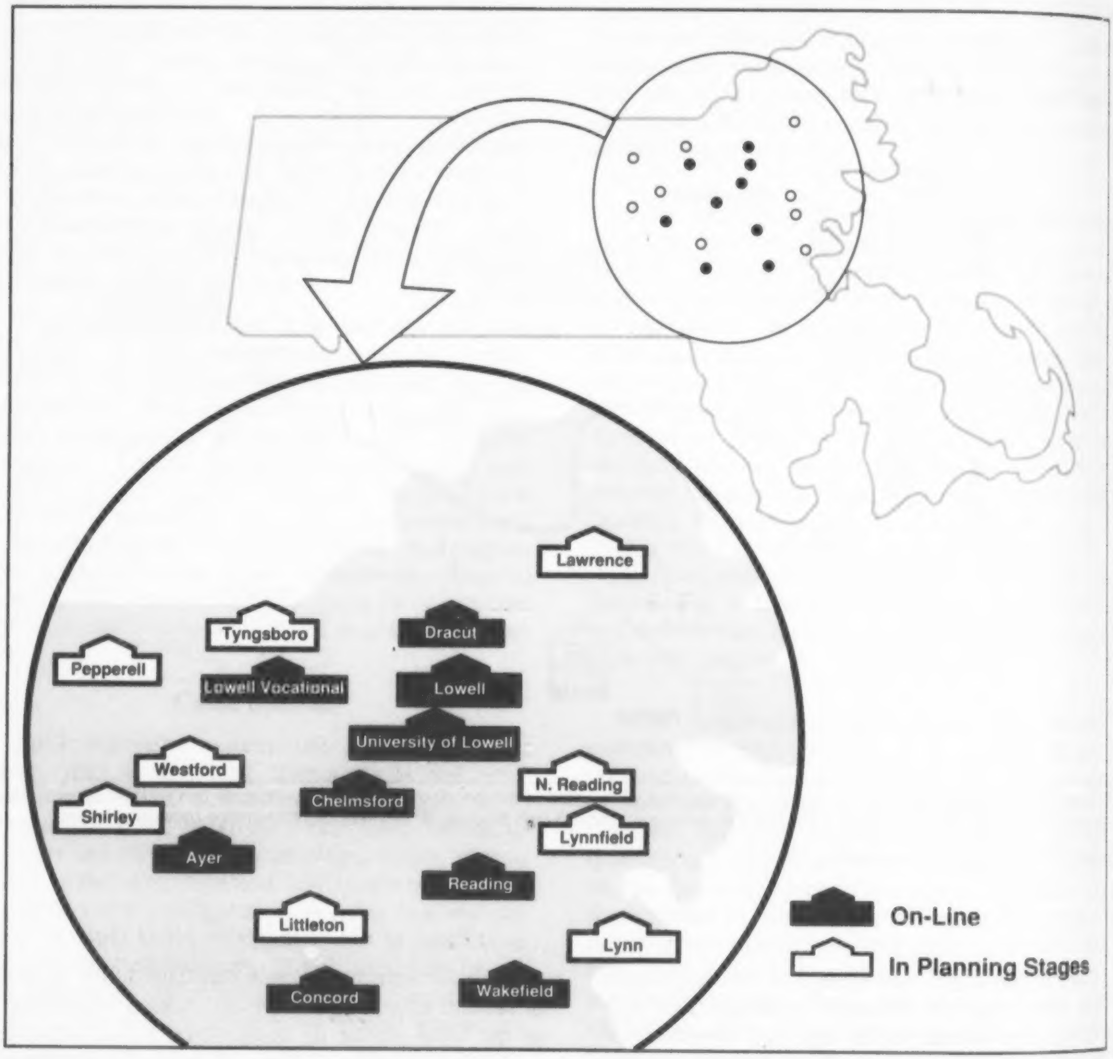
Converting a one-way system to two-way operation may require extensive redesign and upgrading, depending on the age and condition of the system. Two-way capability can be accomplished by running an additional dedicated cable from the school to the cable headend to allow signals to be sent back, but this can be very expensive. (See appendix B.)

Regulation

The main instruments of regulation of the cable companies are the Cable Act of 1984 and the local franchise process and agreement. These franchise agreements may provide opportunities for school systems to gain access to cable programming and capacity. For example, the local public agency signing the agreement could mandate public access or require educational channels. School connection to the local public or institutional cable network could be required. Many franchise agreements already specify that a number of channels be made available for public access or educational uses. **Many schools, however, have limited access or none at all. As cable franchises come up for renewal, local educators may increase pressure on the cable companies to connect unwired schools.**

The growing move to reregulate the cable industry because of alleged monopolistic practices could have major impacts on educational

Figure 3-7—University of Lowell Instructional Network


Lawrence
Tyngsboro
Dracut
Pepperell
Lowell Vocational
Lowell
University of Lowell
Westford
N. Reading
Chelmsford
Shirley
Lynnfield
Ayer
Reading
Littleton
Lynn
Concord
Wakefield
On-Line
In Planning Stages

The University of Lowell Instructional Network is a two-way cable television/microwave system that local schools use to share live interactive classes. Each school can transmit and receive courses or other educational programming.

SOURCE: University of Lowell, 1989.

uses of cable television systems.[34] Possible changes in the Cable Act of 1984 could allow communities more direct control over cable operations, and could allow telephone companies to compete with the cable operators in the provision of video services.[35] Cable companies may be bought out by the telephone companies or form new relationships with them if existing cross-ownership rules are relaxed.

Issues and Future Implications

Cable television systems are an available telecommunications resource in many parts of the country. Cable penetration to the Nation's households is now 50 percent, with cable lines passing 83 percent of all American homes.[36] An estimated 55 to 60 percent of schools have cable hookups, and 80 percent of the Nation's schools are in cable franchise areas.[37] **However, even if a school has access to cable, it may be of limited value if classrooms are not wired to receive the signals.** In many cases, the cable connection only reaches one classroom or office. Few schools have all their classrooms wired to take advantage of cable-delivered programming.[38] Wiring all classrooms for cable is expensive, and communities negotiating franchises might require not only that the school be connected, but that all classrooms be wired as well.

Access to cable channels that could be used for distance learning is not assured. In many areas, commercial programming and other commitments fill existing capacity. Cable operators may resist reallocating channels for distance education programs or courses that have limited audiences.[39] Current cable system channel capacity is constrained by the limits of coaxial cable; channel capacity cannot be easily upgraded short of laying more cable. The deployment of fiber optic systems by cable companies may alleviate this problem. Fiber optic cable systems can transmit up to 150 channels. This new capacity combined with more advanced switching designs could allow cable companies to offer many advanced services such as two-way point-to-point video and computer networking.[40]

Cable company interest in distance education varies, but appears to be increasing. In Michigan, for example, of the 27 projects identified in the State's inventory of educational telecommunications, all involved local cable companies as participants, even if the system was not cable-based.[41] In some States, districts have had difficulty getting cable companies to participate in distance education projects; with the formation of the Alliance for Cable Education by several major cable company operators and programmers, opportunities to use cable systems for education are likely to increase.

Microwave Systems

Point-to-point microwave systems, as opposed to ITFS, operate in various frequency bands.[42] They can transmit audio, data, or video in either a one-way (simplex) or two-way (duplex) format. These systems require a clear line-of-sight between sender and receiver, making the signal sensitive to terrain and

---

[34] The issue was raised in testimony before the Senate Subcommittee on Antitrust, Monopolies, and Business Rights of the Committee on the Judiciary, Apr. 12, 1989.

[35] This issue is the focus of both congressional and FCC interest. Further Notice of Inquiry and Notice of Proposed Rulemaking in CC Docket No. 87-266, *In the Matter of Telephone Cable Television Cross Ownership Rules Sections 63.54-63.58.* The issue also came up at various points in testimony before the Senate Subcommittee on Antitrust, Monopolies, and Business Rights of the Committee on the Judiciary, Apr. 12, 1989.

[36] U.S. Department of Commerce, National Telecommunications and Information Administration, *NTIA Telecom 2000* (Washington, DC: U.S. Government Printing Office, October 1988), note 1, p. 563.

[37] "Turner to Launch 'CNN Newsroom' in High Schools," *Broadcasting*, May 1, 1989, p. 116. A survey just completed by Jones Intercable indicates that approximately 1,100 of 1,500 schools passed by cable in their franchise areas have access. Gregory Liptak, Jones Intercable, personal communication, July 1989.

[38] The Dallas Independent School District is presently wiring all the classrooms in its school buildings, allowing students and teachers to access cable television, telephone, and computer services, at a total cost of $3.8 million. Diana Radspinner, director of media services, Dallas Independent School District, July 1989.

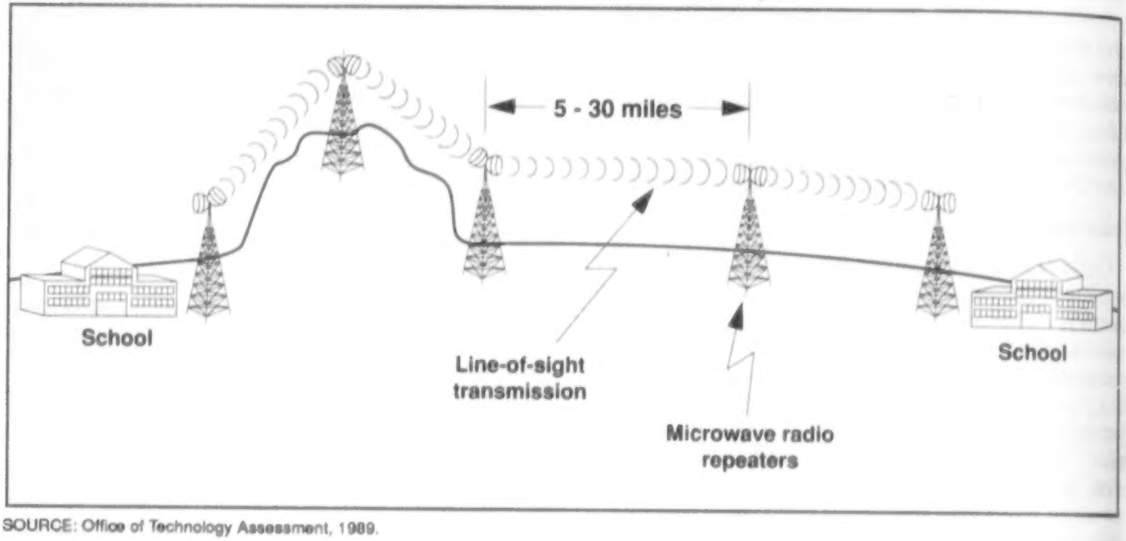
[39] One creative solution was found by the South Berkshire Education Collaborative in Massachusetts. The cable company was in the process of upgrading the system, and instead of tearing down all the old trunk lines (a costly undertaking), they leased them to the schools for $1 per year.

[40] One such advanced system is now being installed in Augusta, GA, by Jones Intercable. The company is installing fiber optic trunk lines to support what it calls a Cable Area Network. The system will offer more channels more economically than the present all-coaxial cable network. Also, the company is laying more fiber cable than it currently needs, giving it a huge unused channel capacity, some of which may be used for educational applications. Liptak, op. cit., footnote 37.

[41] Michigan State Board of Education, *Inventory of Instructional Telecommunications Systems in Michigan* (Lansing, MI: March 1989).

[42] 900 MHz, 1.9 GHz, 2.1 GHz, 6.0 Ghz, 12.0 GHz, 18.0 GHz, and 23.0 GHz.

Figure 3-8—Microwave Communication System



SOURCE: Office of Technology Assessment, 1989.

buildings. (See figure 3-8.) At each transmit/receive site, microwave systems require towers, antennas, transmitters, and receivers.

There are two types of point-to-point microwave systems: short-haul and long-haul. Short-haul systems typically have a range of 5 to 15 miles, suitable for local communication between two schools. One university, for example uses a short-haul microwave link to reach a high school not served by the local cable company. These new short-haul systems ". . . are relatively simple to construct and operate, and require no State regulatory approval or right-of-way."[43] The cost of these systems has fallen significantly as the cost of the electronic components has declined. Development of digital microwave technologies has also improved performance for some signal types. All of these changes have resulted in a dramatic increase in the use of microwave technology for short-haul applications.[44]

Long-haul systems typically have a range of up to 30 miles between towers, depending on transmitter power, geography, dish size, and receiver sensitivity. In the recent past, multiple links of long-haul microwave were used extensively for the Nation's long distance services. At this point, fiber optic trunks have largely replaced these microwave facilities. Typical equipment lifetime is 7 to 10 years.[45]

Regulation

Microwave frequencies are regulated by FCC, and licensing is required for all transmitter sites because of interference concerns, and is necessary for receive sites desiring protection from possible new sources of interference. Local zoning ordinances may affect placement of towers. In some cases, towers cannot be built near the school, but instead must be located some distance away and connected to the school via coaxial or fiber cable.

Issues and Future Implications

The lower microwave frequencies are very crowded in high traffic areas. They may be difficult to obtain. Many of the newer microwave links being installed, such as the University of Lowell's, use the relatively less crowded frequencies at 18.0 or 23.0 GHz.[46]

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[43] Peter W. Huber, *The Geodesic Network: 1987 Report on Competition in the Telephone Industry* (Washington, DC: U.S. Government Printing Office, January 1987), pp. 2.13-2.14.

[44] Ibid.

[45] Some of the descriptive material in this section comes from Karen Kitchen and Will Kitchen, *Two-Way Interactive Television for Distance Learning—A Primer* (Alexandria, VA: National School Boards Association, May 1988).

[46] For more examples, see Bruce Jennings, "Short-Haul Microwave—A Versatile Solution," *Telecommunications*, vol. 22, No. 6, June 1988, pp. 47-48.

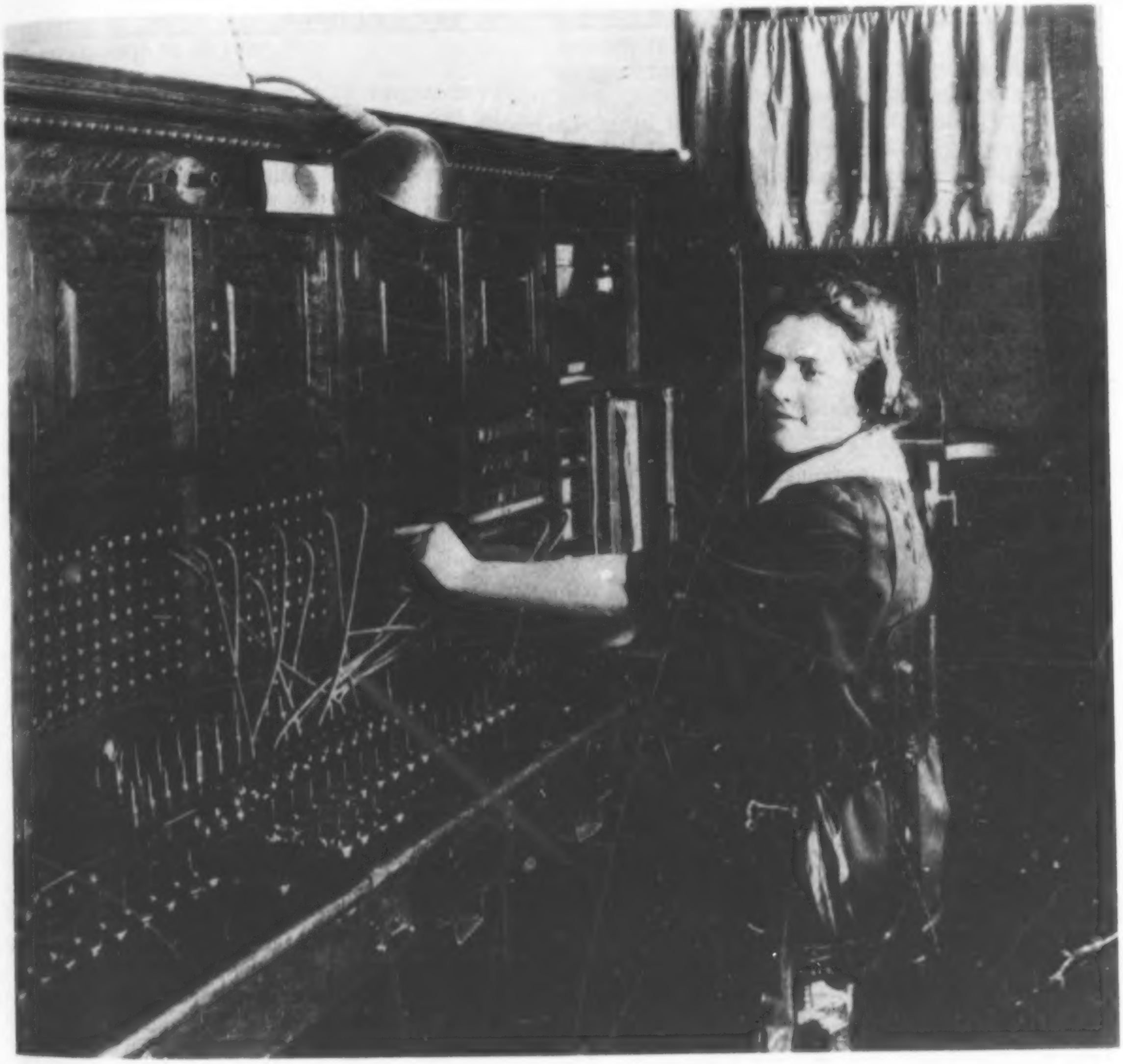

Photo credit: Library of Congress

The public telephone network has come a long way since the early days of operators asking, "number please." Today's digital switches connect up to 300,000 calls per hour.

Public Switched Telephone Network

The Public Switched Telephone Network (PSTN) uses a combination of technologies including fiber optics, copper wiring, satellite, and microwave to transmit audio, data, and limited video signals. (See figure 3-9.) PSTN has several characteristics that make it unique among the systems examined so far. It is a public network; anyone can use it. The network is ubiquitous; it goes just about everywhere.[47] It is a switched network. Each user has a unique address (telephone number), which allows

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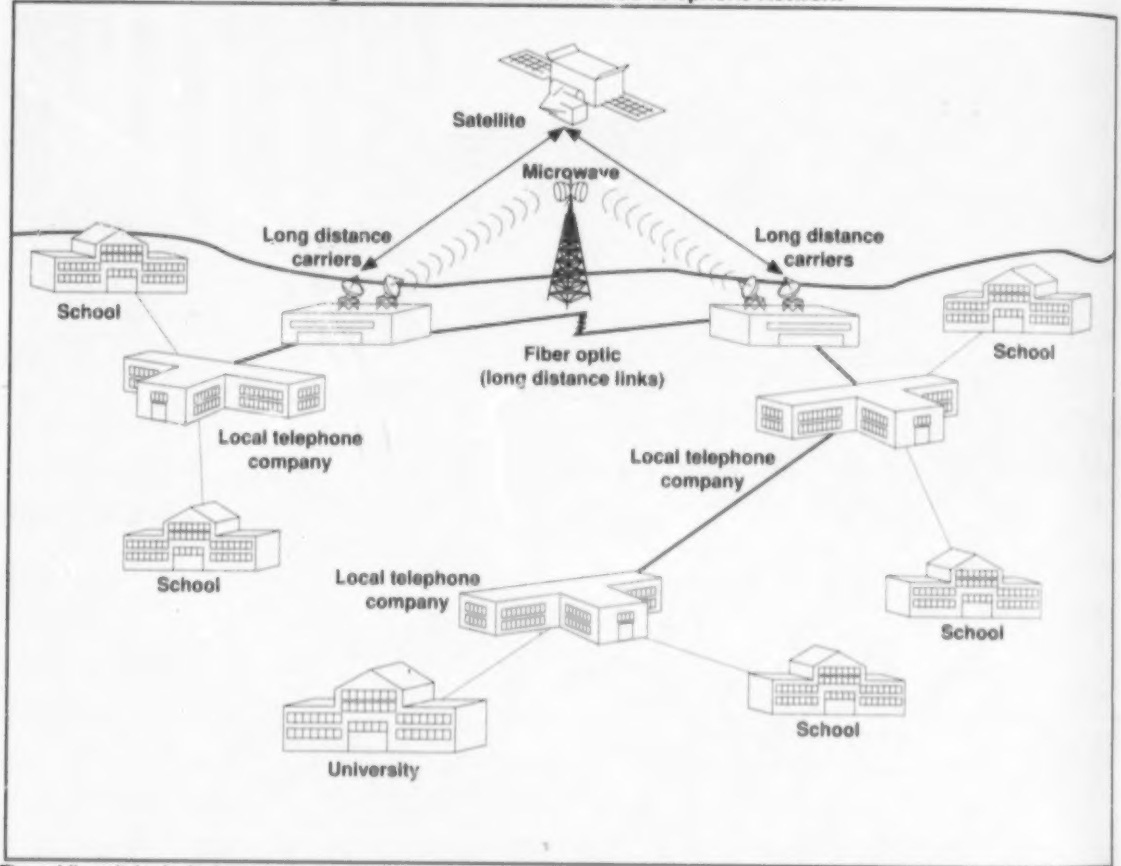
[47] National Telecommunications and Information Administration, op. cit., footnote 36, p. 206.

Figure 3-9—The Public Switched Telephone Network


Satellite
Microwave
Long distance carriers
Long distance carriers
School
Fiber optic (long distance links)
School
Local telephone company
Local telephone company
School
Local telephone company
School
School
University

The public switched telephone network uses many technologies to connect subscribers near and far. Although used primarily for voice services today, in the future the public telephone network may become more a public information network, capable of carrying conversations, computer communications, and video programming.

SOURCE: Office of Technology Assessment, 1989.

the network to connect any two points directly. It is a two-way network; **any site on the network can both send and receive. Any site can originate transmission and programming.**[48]

Since the divestiture of the Bell Operating System in 1984, PSTN has been changing rapidly. Several trends are driving this change. The network is increasingly digital. The use of digital fiber optic lines is pushing implementation of other digital technology such as digital switches. These switches (which are actually specialized computers) are essential for the development of the intelligent network and the Integrated Services Digital Network (ISDN). Further, **fiber optics and digital technology are the prerequisites for advanced broadband networks capable of carrying high-speed data and switched video applications. Broadband**

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[48] This is different, for example, from cable or satellite systems, which usually function as point-to-multipoint broadcast technologies; they have limited switching and addressing capabilities. In addition, these systems are essentially one-way; they are not usually designed for two-way operation (this is less true now with satellite data networks).

capabilities in PSTN are not expected to be widespread for 5 to 20 years.[49]

ISDN represents the next step in the integration of voice, data, and video services. ISDN is an end-to-end digital network that will allow users to send audio, data, and video signals over the same line simultaneously. Although not all the relevant standards have been worked out, manufacturers are already making ISDN equipment, and there are more than 60 trials under way.[50] As yet, no distance learning projects have been attempted over a public ISDN facility.

The timeframe for ISDN services remains unclear. Narrowband ISDN technologies (which can operate at 1.544 Mbps, but cannot offer full-motion video services) are being offered now, but broadband applications of ISDN, including video, are not expected to appear until 1995 or be widely available until 2000. The rate of ISDN (broadband and narrowband) deployment will depend on technical factors such as how quickly digital switches are installed, the implementation of new signaling systems such as SS7,[51] and the cost and availability of optical fiber. The regulatory environment and the demand for wide bandwidth services, such as videophone applications and high-speed data transfer, will also influence the rate of deployment.[52]

PSTN is becoming increasingly intelligent. New and varied services give users more control over their telephone. Hardware and software development is making it easier to control and customize communications. Network management, services, and features reside increasingly in software instructions rather than hard-wired connections. These software-defined switches and networks are more flexible than in the past and are easier to change. In many cases, upgrading a system or providing new features means only changing a circuit board or software module, not rewiring the whole system. Such applications may serve as the precursor to more advanced services including educational services. For example, users could dial in and gain access to various multimedia courseware provided by independent providers.

Current regulation has opened up the network to more competition,[53] while stifling the development of new services and hardware in some fields, especially new information and video services.[54] As competition intensifies in various parts of the network, more choices may open up for schools. The continuing problem for State and Federal regulators is how to assure innovation and competition while still protecting the consumer; it is a tense balance between the opportunities of competition and the threats of monopoly.

Future development of PSTN is closely tied to the implementation of fiber optics. Fiber is increasingly being used as the public network becomes digitized. The trends and issues surrounding the deployment of fiber optic technology will have a direct impact on PSTN.

Fiber Optics

Fiber optic systems work by converting the analog electronic signals of voice and video and the digital signals of data into light signals and transmitting them over thin strands of glass. Usually, these systems send information digitally, although some video applications do use an analog format. For digital transmission, analog signals are converted to digital bits, and then are transmitted by lasers or light emitting diodes (LEDs) as pulses of light along the

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[49] As of 1986, digital switches accounted for 40 percent of central office switches. Eighteen percent of Bell Operating Companies (BOCs) switches were digital in 1986, but the independent telephone companies, which account for more than one-half of the installed base of central office switches had a much higher percentage of digital equipment. Fifty percent of their access lines are digital, while the BOCs access lines are only 33 percent digital. At this point, analog switch growth is limited to additional lines being added to existing analog switches. National Telecommunications and Information Administration, op. cit., footnote 36, pp. 312, 314; Bob Keely, district manager, Bell Communications Research, personal communication, Mar. 31, 1989.

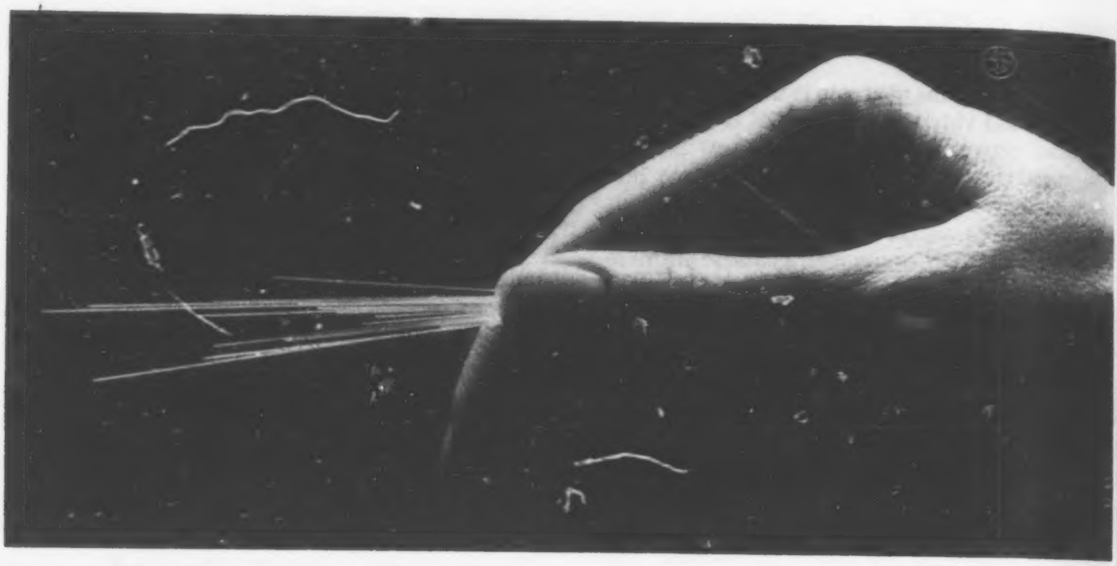
[50] Michael Warr and Ellis Booker, "Open the Box and Look Inside," *Telephony*, vol. 215, No. 24, Dec. 12, 1988, p. 30.

[51] Signaling System 7 is the latest in control systems for the public network. It allows greatly enhanced services to be provided to users such as customized 800 services and caller identification.

[52] For a discussion of the factors surrounding the development of ISDN see, Rolf T. Wigand, "Integrated Services Digital Networks: Concepts, Policies, and Emerging Issues," *Journal of Communications*, vol. 38, No. 1, winter 1988.

[53] An example is the proliferation of regional backbone networks (which are primarily fiber-based) that offer an alternative to traditional long distance carriers. Proposed systems in many States, including Indiana and Wisconsin, have met stiff challenges from local and long distance carriers. Mary Walker, "Competition in the Local Exchange," *Telephone Engineer and Management*, Aug. 1, 1988, p. 82.

[54] The Modification of Final Judgment and the Cable Act of 1984 restrict the phone companies to only transporting video, they may not originate or own the content passing over their lines.



Is it spaghetti? No. Fiber optic systems use hair thin strands of glass and signals of light to carry voice, video, and data.

fiber strand. Receiving equipment senses these light pulses, converts them back to electronic digital signals, and then back to analog form for output. The cost of analog fiber optic systems is lower than digital systems because digital systems require expensive equipment to convert the signals from analog to digital and back. Digital transmission, however, allows signals to be combined and compressed, permitting many more signals to be transmitted. Signal quality is comparable for both systems. In theory, **fiber optics offers almost unlimited speed and capacity for voice, data, and video applications.** Because information is transmitted as light, fiber optic signals are much less susceptible to interference from weather, radio frequency transmissions, or electromagnetic "noise," which limit most conventional analog transmission systems. In practice, however, the capacity of fiber optic systems is limited by the speed of the transmitter and the sensitivity of the receiver.[55] The capacity of these systems, however, is still far greater than other transmission media.

Fiber optic systems have been implemented rapidly by the telephone companies and in large private networks whose data or video needs cannot be met by PSTN.[56] At first, the high cost of such systems made them economical only for high-density applications such as long distance telephone trunk routes or video applications. As costs have fallen, fiber has been deployed in many new areas and applications. Continued advances in fiber optic technology promise even higher capacities, lower costs, and more rapid deployment. For example, in a trial currently being conducted around the country, fiber is being used to deliver broadcast video from five television networks to eight cities.[57] The system is expected to offer lower cost, higher quality transmission, greater security, and the ability to deliver as yet undefined services. The development of digital television receivers will eliminate the need for expensive video codecs. The accessibility and availability of fiber optic systems should increase dramatically in the next several years.[58]

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[55] The fastest fiber optic systems commercially available today run at 3.4 giga (billion) bits per second (Gbps); most systems operate at 565 Mega (million) bits per second (Mbps). The average length between repeaters is approximately 30 miles.

[56] Fiber optics is spreading quickly in the Nation's telephone system. First used almost exclusively for long distance links on high traffic routes, fiber is now being installed in the local loop and even to individual (new) homes in some areas. One projection says that most of the homes in the United States will be served by at least one fiber optic link by 2008. Robert M. Pepper, *Through the Looking Glass: Integrated Broadband Networks, Regulatory Policy and Institutional Change* (Washington, DC: Federal Communications Commission, November 1988), p. 16. Presently, 50 percent of all intercity traffic is now carried on fiber. All the major long distance carriers have extensive fiber networks, and regional networks are proliferating as well. National Telecommunications and Information Adminstration, op. cit., footnote 36, pp. 76, 219, 260.

[57] "Fiber Optic TV Trials Take Key Step," *High Technology Business*, vol. 8, No. 12, December 1988, p. 37.

Regulation

Regulatory decisions will play an important role in determining how the public network develops. The huge capacity and high cost of broadband development present the telephone companies and regulators with a classic problem. At present there are no services the telephone companies can offer that justify putting in fiber optic lines directly to end users. Putting in capacity for future use that consumers pay for now, called "gold plating," has not been popular with State regulators. Development may go slowly depending on demand for new types of services and features, and how regulators react.[59]

The restrictions placed on the Bell Operating Companies (BOCs) by the Modification of Final Judgment (MFJ) regarding manufacturing and design of equipment, provision of long distance services, and provision of information services may hamper BOCs' ability to offer the enhanced services needed for distance learning. BOCs cannot offer the complete service schools want, in many cases, especially when video is desired. In other instances, BOCs find it uneconomical because of restrictions or requirements of the MFJ or State public utility commissions. Telephone companies are currently prohibited by the Cable Act of 1984 from providing video content, although they can transport video signals. Easing restrictions may encourage the telephone companies to make more resources available to education. The resolution of the cable/telephone company cross-ownership debate, changes in the Cable Act and the MFJ, and evolving State regulation will impact what (video) services the telephone companies provide.[60] The final outcome of these deliberations will significantly affect the range of options for distance education delivery systems.

Issues and Future Implications

There are a host of issues that will determine how the public switched network evolves in the next decade.[61] **PSTN may become less a telephone network and more a general-purpose broadband network capable of carrying all types of traffic, including audio, data, and video.** Because telephone companies cannot yet provide all the services many educators want, a few schools have built their own customized systems. In the future, schools may not have to bypass the public network. Transmitting a live telecourse with full audio and video interaction may be no more difficult than making a telephone call is today. **However, because of the many political, economic, and regulatory issues involved, the timeframe for the development of this network is uncertain.**

The future of ISDN is unclear. The trials and services now available are all narrowband applications for which services and pricing are still evolving.[62] Broadband ISDN (B-ISDN), which is not available yet, will offer users advanced data and voice services as well as full-motion video applications in addition to existing narrowband services. Some of the services that broadband fiber optic networks are expected to offer include: videoconferencing and video transmission, high speed data and fax, and HDTV.[63] (See figure 3-10.) Many of these services have clear applications in distance learning projects. Since delivery of these services will require the capacity of fiber optics transmission, the rate of fiber deployment may determine how and when such services become available for school use. B-ISDN

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[58] Pepper, op. cit., footnote 56.

[59] Long amortization and depreciation times, for example, mean that the phone companies cannot recover costs on equipment with short lifecycles. This may prove to be a disincentive to future investment in the network. The debate about universal service and what it should be is also relevant, because if universal service is redefined to include access to high bandwidth services such as video, the introduction of fiber may accelerate.

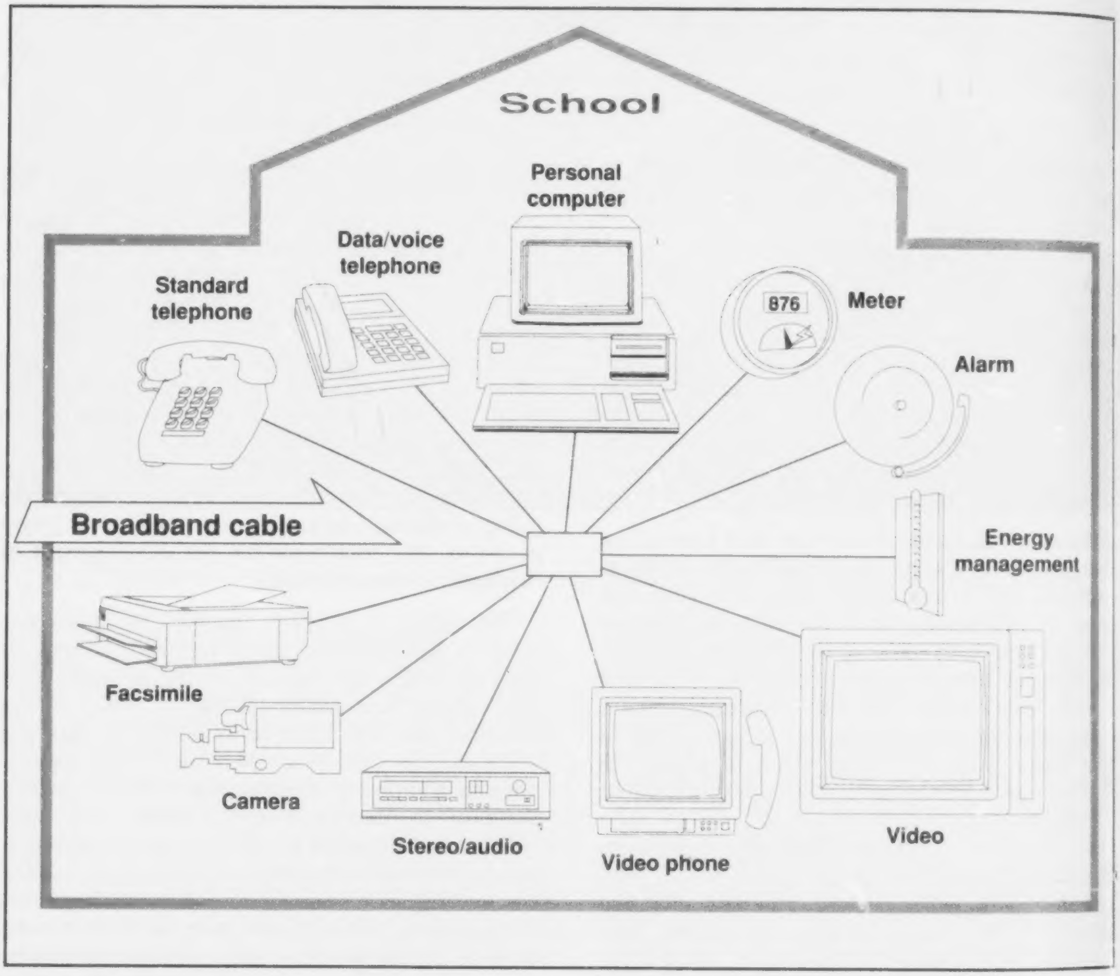
[60] For a discussion of the legal and regulatory issues surrounding the telephone companies' provision of video services see Pepper, op. cit., footnote 56.

[61] These are discussed in more detail in Dennis Gilhooly, "The Politics of Broadband," *Telecommunications*, vol. 22, No. 6, June 1988, p. 51.

[62] They offer speeds of either 144 kbps (2B+D) or 1.544 Mbps (23B+D), which allow the transmission of enhanced voice and data services, but only limited video applications.

[63] Many see video services as driving the deployment of fiber optics and the development of a broadband public network. See Andrew C. Barrett, "The Potential of Fiber Optics to the Home: A Regulator's Perspective," *Public Utilities Fortnightly*, vol. 123, Jan. 19, 1989; Pepper, op. cit., footnote 56. A limiting factor in the deployment of broadband video applications is the switching equipment available. Video switching technology is still in the early developmental stages. Although technically possible, widespread application of broadband switching technology will depend on standardization and demand, and is still probably many years away. Keely, op. cit., footnote 49.

Figure 3-10—Information and Communications Services of the Future


School
Personal computer
Data/voice telephone
Standard telephone
Meter
876
Alarm
Broadband cable
Energy management
Facsimile
Camera
Stereo/audio
Video phone
Video

In the not-so-distant future, schools will have access to a wide variety of information and communications services. Advances i transmission and switching capabilities will bring audio, video, and data services from many sources directly to the school.

SOURCE: Office of Technology Assessment, based on information from Bell Atlantic, 1989.

may evolve gradually, as fiber capacity is put in, or it may (in some areas) "leap-frog" existing technologies, moving users directly to advanced broadband applications. Availability of broadband services will be uneven across the Nation for some time.

Because of the newness of these services, prices have yet to be determined. Pricing policy, especially in the area of video services, is evolving as the telephone companies gain more experience with video transmission and processing technologies. No standardized price structure or tariffs exist for multichannel video service,[64] and in many cases, the telephone companies have had to price services on a case-by-case basis.

Integrating the various ISDN "island" field trials may be difficult because each trial uses equipment and software made by different manufacturers. Schools using ISDN in one part of the country may not be able to connect with schools served by other phone companies, or the services and features offered by one phone company may not be available outside that company's service area. As ISDN moves into the implementation phase, standardized equipment and interfaces could resolve these differences.[65]

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[64] Dennis Pellant, executive vice president, Tele-Systems Associates, Inc., personal communication, Aug. 10, 1989.

One of the fundamental problems schools face as they try to interconnect their networks is the lack of uniform national standards governing digital video and computer interconnection.[66] With the proliferation of new technologies and new competitors, and in the absence of a national standard-setting authority, many interpretations of standards have emerged. Uncertainty about standards and compatibility may complicate schools' hardware and software decisions.

Distance education needs may help justify broadband and ISDN applications. In exchange for permission to add capacity, telephone companies may agree to install advanced systems in schools. Education could be an important factor in expansion of the telephone network. The telephone companies are beginning to recognize the potential of the education market, and schools that want fiber optic systems will be seeking help from local, regional, and national telephone companies and providers.

In most instances, schools implementing a fiber system have to build the system "from the ground up," laying new fiber from school to school and classroom to classroom. In the near future, this may not be the case. With an increasing prevalence of fiber in PSTN, and with improved switching capability, districts may be able to hook onto existing fiber routes and only have to incur "final mile" costs to link schools and classrooms. In that case, fiber may be competitive, for example, with buying a satellite dish.

Even when ways are found to economically deliver advanced information and video services to schools via the public telephone network, most school buildings lack the internal wiring to fully take advantage of new PSTN capabilities. Telephone connections in individual classrooms are rare. To use computer networking, compressed video, and full video resources, classrooms will require wiring—a telephone jack, a cable outlet, or a connection to an outside satellite or fiber equipment. While new schools can be planned and wired easily, retrofitting some older buildings may prove difficult and costly.[67]

PSTN was engineered for analog voice applications. Newer services, such as high-speed data transmission and videoconferencing, strain system capacity and switching capability. While long distance lines and major trunk lines are increasingly fiber-based and have huge capacities, local telephone lines remain largely copper, limiting their ability to handle high-speed or high-bandwidth applications. Some copper lines can be "conditioned" to provide transmission rates up to 1.544 Mbps, but even this may not be enough for some video applications.

COSTS OF TECHNOLOGY SYSTEMS

> [T]here are no simple formulas to help estimate the cost of a technology system.[68]

The costs of distance learning technologies are difficult to analyze because technological options are so varied and are changing so rapidly. The technologies used in distance education are more powerful today than in the past, offering advanced capabilities and improved performance. At the same time, costs for the electronic components that make up these technology systems have been steadily declining. (Equipment and related costs for individual technology systems are discussed in appendix B.) These two trends have produced systems that are increasingly less expensive for the capabilities they offer teachers and learners. Local schools and districts are finding that they can now afford (often with some help) the technology tools they need. Five examples are illustrative:

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[65] There are broadband applications available with today's technology, however. Switched Multi-Megabit Data Service (SMDS) is a service concept that will offer high-speed (45 Mbps) data communication services for computer communication using technology available now. This service will be available in the early 1990s.

[66] With electronic mail (e-mail), for example, it has just become possible to send an electronic message through various services or from one company to another. All the various e-mail systems have been (and most probably remain) incompatible; each has its own formats and protocols, which make interconnecting them very difficult.

[67] See footnote 38.

[68] National School Boards Association, *Planning for Telecommunications: A School Leader's Primer* (Washington, DC: 1989), p. 10.

- The Panhandle Shar-Ed Video Network was installed at a total cost of $340,000. This included laying fiber between four schools, outfitting schools with all necessary hardware, and maintenance and operation for 5 years. Annualized costs come to $17,000 per site. After 5 years the local telephone cooperative will charge the schools a minimal fee for continued maintenance and use.
- In the Missouri Education Satellite Network, participating schools pay a one-time fee of $8,000 for equipment and an annual programming fee of $1,000. Tuition costs for student courses and staff development are extra. Participating schools that choose to lease hardware and services pay an annual fee of $3,500 plus tuition.
- The Kentucky Educational Television initiative will construct a satellite uplink, install satellite downlinks at each of the State's 1,300 elementary and secondary schools, and build a new Telecommunications Center, at a cost of $11.4 million.
- Houston's InterAct ITFS transmitting equipment cost $330,000. This system reaches participating schools within a 50-mile radius around the city. Participating schools have invested an average of $12,000 for hardware.
- Since 1985, the Pennsylvania Department of Education has provided $952,000 to fund the Pennsylvania Teleteaching Project, a statewide audiographics project. Funding has supported a pilot program and has purchased equipment for 48 schools. Funds have also been used to upgrade software and hardware, for staff training, and for maintenance. Local schools pay telephone charges, about $45 per month depending on use.

Varying equipment requirements, use of local resources, and the individual nature of each system makes cost comparisons between different technologies impractical. For example, one study that compared costs at five hypothetical districts linked by a variety of technologies showed real differences in the absolute cost of the various configurations,[69] but the results were judged to be of limited value because the hypothetical construction was too contrived, and because the capabilities of the systems varied so greatly.[70] Key factors affecting overall cost of distance learning systems include:

- *Instructional design*: what types of connections are needed? Instructional design requirements, particularly interaction, will affect the cost and type of system chosen.
- *Scope of the system*: how many sites will the system serve? More sites will increase the cost of the system, but costs per student or site may decrease as economies of size are realized.
- *Existing infrastructure*: what telecommunications resources are available? Schools with access to local resources, such as cable television systems or university ITFS networks, may be able to use those resources at minimal cost. Other schools may have to build or lease facilities.
- *Partnerships*: who can schools share costs with? Cooperative arrangements with business or higher education can substantially reduce costs by sharing facilities and resources.
- *Engineering requirements of the system*: what are the technical requirements of the system? Longer distance or rough terrain may increase costs.
- *Financial arrangements*: will it be cheaper to buy or lease capacity? Many combinations are also possible, such as owning the hardware and leasing the transmission channels.
- *Programming*: what types of programming are desired? Broadcast quality video production is very expensive. Other forms of audio, video, or computer materials may be far less expensive.

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[69] State of Minnesota Task Force on Instructional Technology, *State of Minnesota Task Force on Instructional Technology: Report to the Legislature* (St. Paul, MN: December 1988).

[70] Joan Wallin, Minnesota Department of Education, personal communication, June 16, 1989.

Table 3-2—Cost Categories for Distance Learning

nitial:	
Capital	Infrastructure and hardware costs, such as satellite dishes, Instructional Television Fixed Service and microwave towers, computers, fiber optic or coaxial cable, monitors, cameras. (Equipment and related costs for individual technology systems are discussed in app. B.)
Development	Costs needed to actually put the system into operation. These costs cover initial professional training, program development, materials acquisition, staff support, management, and miscellaneous equipment. Such costs are valued not only by actual dollars spent, but also in the time invested.
Ongoing:	
Programming	Costs paid to acquire, produce, or use educational programming or instruction. These include subscription costs, costs for individual courses or materials, and any other costs associated with producing a course or program.
Operation and maintenance	Costs associated with continued operation of the system. Some costs include: maintenance and repair; salaries for teachers, aides, and technicians; and expendable materials. Also included in this category are recurring costs associated with training technical staff, teachers, and aides.
Transmission	Costs of satellite transponder time, or long distance telephone charges, for example.
Expansion	Costs that result from enlarging an existing program. These include: new equipment, personnel, and management costs.

SOURCE: OTA analysis, from Anne Batey and Richard N. Cowell, *Distance Education: An Overview* (Portland, OR: Northwest Regional Educational Laboratory, Technology Program, November 1986).

- *Training*: who must be trained and what expertise is already available? Experienced teleteachers and support staff will need less training and support. Inservice and staff development costs will vary depending on the types of technology used and how the course is designed.

Schools implementing distance learning systems have two types of costs: 1) *initial costs* that include equipment and development; and, 2) *ongoing costs* that include programming, transmission, operation and maintenance, and system expansion. (See table 3-2.) The most visible costs are the startup costs, which can be quite high, especially if few resources exist and the system has to be built "from the ground up." High startup costs can make some technology options too expensive for school districts to afford on their own.

In the long run, the ongoing expenses associated with operating a distance learning system may be much more substantial than the initial costs. The equipment necessary for a school to participate in Missouri's Educational Satellite Network, for example, costs $8,000, but annual subscription costs for receiving programming could soon equal or exceed that amount and will continue to accrue each year that schools subscribe. School districts that only use free programming from public television or cable programmers may have minimal costs. Districts that share local teachers and resources electronically tend to have lower programming costs, although for districts or schools producing their own programming, costs will be higher. Schools that buy courses from commercial providers pay subscription and/or per course costs. Other ongoing costs associated with distance learning include operating expenditures for maintenance and repair, transmission, and any costs associated with expanding the system.

Opportunities exist for local schools to reduce (or even eliminate some) costs by sharing infrastructure resources and programming costs with other districts or education agencies, private business, higher education, and State and local government. In the Panhandle Shar-Ed Video Network, for example, four neighboring school districts secured funding from private foundations and from the State and, working in collaboration with the local telephone cooperative, are sharing the costs of constructing and operating a fiber optic system for the schools and the community. Institutions of higher education, with technology capacity and instructional resources, become natural partners for K-12 distance education efforts.

Growing opportunities exist for schools to share ongoing expenses as well. By expanding the uses of a system, schools can share costs with other user groups. The State of Maine, for example, will use its higher education telecommunications network to serve other learner communities after regular school hours. In this way, the resources of the network are more fully utilized, and costs can be borne by more users. Local schools can similarly reduce operating costs and share benefits with local businesses, governments, and community groups.

TRANSMIT ON

Photo credit: Bellcore

Sophisticated video processing techniques and fiber optic capacity will enhance future distance education efforts.

SUMMARY

Improvements in telecommunications and information technology have given schools many options for delivering instruction and educational resources to distant students and teachers. Further advances in technology, including more powerful computers and storage devices, the deployment of fiber optics, better signal processing and compression, and the rapid advance of digital technology, promise even more opportunities in the future. The capabilities of distance education will expand as information processing and telecommunications technologies continue to converge, as audio, data, and video become easier to combine, store, and use, and as various technologies and networks are linked.

This explosion of technological possibilities presents schools and educators with a host of new challenges and opportunities. Schools will face an increasingly complex array of technologies and providers. Many new players, including the telecommunications industry and the post-secondary and higher education community, can help sort through the choices. Educational users can become leaders in advancing the development of new education technologies, applications, and experiences. Education and industry can work together.

Today, the technical capability exists for schools to provide effective distance education, and a growing number of efforts utilize available telecommunications infrastructure and information resources. However, access to telecommunications resources varies considerably in different locations. Channels that could be used to provide distance education are saturated in many areas, high-capacity fiber optic lines are concentrated in more populous areas, and schools' internal wiring is often inadequate. As a result, most efforts will require additions to existing systems and/or the construction of entirely new systems.

A major factor in the advance of telecommunications technologies and services is the sometimes confusing regulatory structure in the United States. Regulations and policy regarding computer and telecommunications technologies have been largely promulgated with little consciousness of the needs and concerns of education. Transmission costs can be very high and gaining access to scarce communications channels and resources can be difficult for local schools. Future changes to telecommunications policy and regulation, especially those governing the public telephone network and the Nation's cable television providers, could radically affect the options available to schools. To protect rising interest and investment in educational telecommunications, the education community needs a voice in determining how these policies are defined.

The future promises vastly more sophisticated telecommunications systems for education. These systems will generate new and different applications as the technologies advance and as students and teachers learn to use the systems more creatively and effectively. These systems have the capability of serving more than just the needs of education—telecommunications is achieving greater importance in encouraging economic development, training the work force, and extending the resources of the information age to all citizens.

Policy options serving immediate needs and long-term goals could include:

- **Support technical assistance to schools and States planning distance learning efforts.** Experiences of those already up and running could be shared more broadly.
- **Review and shape Federal and State telecommunications policy to ensure a coherent use of communications technology for education.** Assuring adequate capacity on telecommunications systems for education at reasonable rates could expand the use of such facilities for distance education and promote the improvement and expansion of existing systems, as well as help to justify investment in new telecommunications resources.
- **Support standards and protocols that promote the integration of different technologies and networks.** The growing national infrastructure for distance education is composed of numerous systems with various administrative and technical frameworks. Efforts to expand the communications infrastructure for education could build on resources already installed, while seeking further connections and flexibility.

Telecommunications and information technologies can advance teaching and learning to new levels. The potential of technology for addressing the needs of education cannot be neglected:

> Technology has the capacity to do more than aid the exchange of information and ideas. It can enhance students' powers of analysis, sharpen their capacity to think critically, improve their writing skills, and increase their ability to develop independent judgments. If used properly, it is likely to alter the learning environment to such an extent that the old institutional models of campuses, classes, lectures, schedules, timetables, and tests will not survive in their present forms. How, when, what, and where we teach will change.[71]

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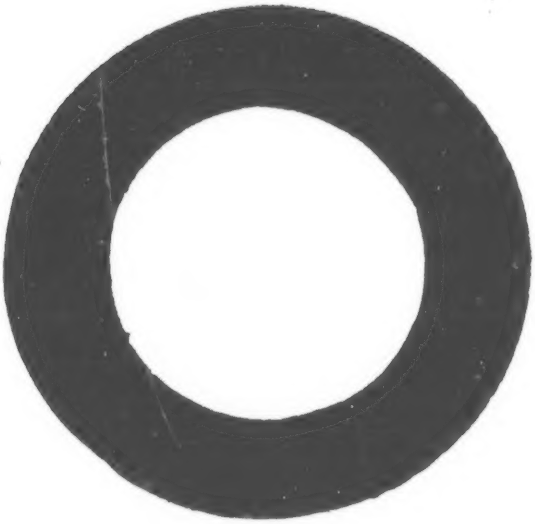
[71] Donald R. McNeil, "Technology Is a Hot Topic, But Its Impact on Higher Education Has Been Minimal," *The Chronicle of Higher Education*, June 7, 1989, p. A44.



Chapter 4

The Teacher Link: New Opportunities for the Profession

Photo credit: TI-IN Network

The key to any successful distance learning course is a good teacher.

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Chapter 4

The Teacher Link: New Opportunities for the Profession

While the intellectual and social demands on teachers have escalated at an astonishing rate since this century began, the nature and organization of teachers' work have changed only a little since the middle of the 19th century. We now live in an age when many elementary school students have their own microcomputers. These students can put some of the most amazing achievements of modern science and technology to work in support of their learning. Yet their teachers are still working with the same job descriptions that teachers had in the mid-1800s, when McGuffey's Readers and spelling slates were the leading educational technology.[1]

INTRODUCTION

Today not every teaching need can be met by applying the traditional classroom model of 1 teacher standing in front of a class of 25 students. In some cases, there may be just a handful of students who need to take a particular course, not enough to justify hiring a teacher. Or a district may be unable to find a fully qualified teacher, especially in specialized or advanced subjects. Because of this mismatch between student needs and fully qualified teachers, many districts are turning to distance learning technologies for help.

Distance learning technologies can bring the teaching profession out of the age of McGuffey's Readers and into the 21st century. The very technologies that can bring better resources into the classroom to help students can also improve the quality of the teaching work force.

Teacher quality is a charged term, subject to debate as to what constitutes teaching excellence. This much is clear, however: we need to find ways to bring into teaching people who are better prepared, and to maintain and upgrade the skills and knowledge of those already in the classroom. We also need to do a better job of utilizing the human resources we already have, to share professional expertise, and to draw on the skills of the most experienced and talented teachers so that their wisdom will be available to others. Distance learning technologies offer a resource for meeting these goals. But to improve teaching via technology, enthusiasm and excitement for technology must be matched with careful attention to three critical factors: involving teachers in the planning and implementation process, accounting for how teaching with technology can change the nature of teaching and the teacher's role, and educating teachers to take advantage of these teaching tools.

FINDINGS

- **A mismatch between student needs and qualified teachers, especially in areas such as mathematics, science, foreign language, or advanced placement courses, has driven many districts to adopt distance learning strategies. The need to provide inservice training and professional development to school staff has been another motivating factor.**
- **The key to success in distance learning is the teacher.** If the teacher on the system is good, the technology itself can become almost transparent. Conversely, no technology can overcome poor teaching; poor teaching is actually exacerbated in distance education applications. But when skilled teachers are involved, enthusiasm, expertise, and creative use of the media can enrich students beyond the four walls of their home classroom. Outstanding teachers can also serve as "electronic mentors" to other teachers.
- **Teachers' concerns about being displaced by technology must be taken seriously.** Systems imposed from above are understandably threatening. However, when teachers are involved in all aspects of planning and implementing distance learning strategies, they can shape the systems to meet the needs of the entire school community.
- **Teachers using distance learning have had to find new ways to structure student-teacher interaction.** Old styles of teaching may not be appropriate or effective. The inherent limitations

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[1] The Holmes Group, *Tomorrow's Teachers: A Report of the Holmes Group* (East Lansing, MI: April 1986), p. 6.

in distance learning technologies can be catalysts for instructional design and teaching techniques that enhance the learning process.

- **Distance education systems offer many benefits to teachers for professional growth.** Courses can make it possible to broaden and update knowledge, enhance skills, or change specialties. Electronic networks give teachers a chance to connect with colleagues and share resources, experience, and teaching. Teachers delivering courses over distance learning systems can focus on their specialties. They can negotiate more flexible, individualized teaching options.
- **Teachers must be trained if they are to use distance learning technologies effectively.** Training opportunities, however, remain limited. Few preservice and inservice programs focus on how to incorporate technology into instruction, create new opportunities for interactivity, or develop materials and use the media most effectively.
- **Distance teaching is not for everyone.** For some, nothing can substitute for the intimacy of the classroom. Those who serve as distance teachers report that it takes more time to prepare for class sessions and more effort to compensate for the separation from their students. They must be more organized. Being on stage at all times can be intimidating. But distance teachers are excited about the opportunity to be innovators, to teach the subjects they love to a wider audience of students, and to use technology as a springboard to creativity.
- **Classroom facilitators matter.** How they work with the distant teacher shapes the style of instruction and affects the success of the effort.
- **The opportunity exists to develop regional or national resources for teacher development over distance learning systems, similar to professional development programs now available for engineers.** One of the reasons for the success of engineering and technical programs is the support provided by employers. Convinced of the crucial need for their staff to keep up-to-date with courses relevant to their work, employers provide not just tuition fees, but classroom space at or near the work site and release time so that employees can participate. If education were to support similar efforts, the current and developing nationwide distance learning infrastructure could make it possible to create a national system of teacher enhancement, drawing on the best resources around the country.

MATCHING EDUCATIONAL NEEDS AND QUALIFIED TEACHERS

Do we have today, and will we have tomorrow, the number of qualified teachers needed to equip our young people to meet the social and economic challenges of the 21st century?[2] It is easier to describe the current situation than it is to project into the future, particularly since the future of schooling is being redefined by many forces. Shifting demographics and social needs, advances in technology, and changing demands on the profession of teaching all contribute to current school reform and restructuring efforts.

Teacher turnover is the factor that most affects the demand for new teachers. Districts continually need to replace teachers who leave the profession before retirement. Of special concern is the fact that much of the current teaching force is nearing retirement. The Department of Education projects that between 1988 and 1997 about 1.6 million new teachers will be needed.[3]

School reform efforts have also pushed hard on the demand side of the equation. State graduation requirements and prerequisites for university entrance have increased demands for curriculum offerings, especially in mathematics, sciences, and foreign languages. Many schools find themselves unable to meet this demand. Technically, few positions for required courses stand vacant, but many schools have had to use teachers who are not fully qualified to fill those positions. The 1985-86

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[2] Much of this discussion comes from James B. Stedman, Congressional Research Service, "Teachers: Issues for the 101st Congress," issue brief, June 1, 1989.

[3] The Department of Education relies on Bureau of Labor Statistics' estimates of teacher attrition in 1983-84 at 4.9 percent for public elementary school teachers and 5.6 percent for secondary teachers. Some analysts challenge these attrition rates arguing that a higher percentage of teachers leave annually, raising the number needed by a substantial margin. Ibid., pp. 6-7.

National Survey of Science and Mathematics Education[4] found that a majority of high school principals reported difficulty hiring fully qualified physics, chemistry, computer science, and mathematics teachers, among others. The situation among foreign language teachers is equally troubling. Forty percent of those responding to a State survey of foreign language teacher availability reported an existing shortage at the elementary level; 48 percent reported shortages at the secondary school level. Furthermore, they expect these shortages to increase: 57 percent anticipated foreign language shortages at the elementary level within the next 5 years, and 62 percent at the secondary level.[5]

Concern has also focused on the number of minority teachers in schools today and in the future. At a time when the proportion of students from minority groups is expanding rapidly,[6] the number of teachers from minority populations is not keeping pace. At one time, 18 percent of the U.S. teaching force was made up of Black teachers. Today the figure is 7 percent, and some estimates suggest that the proportion will fall to less than 5 percent by 1995. Only 2 percent of teachers in public schools are Hispanic.[7] Minority enrollment in undergraduate teacher education programs has remained relatively stable over the last 3 years, never exceeding 5 percent of the total enrollment.[8]

Can the needs for qualified new teachers—especially in these areas of special need—be met through traditional means? Are colleges of education producing enough qualified new teachers? Throughout the 1970s and early 1980s, the number of newly trained entrants graduating from undergraduate teaching programs declined by more than one-half. However, this was a period when teacher demand was also dropping. After years of teacher surplus, in 1985 jobs and job seekers were roughly in balance.[9] Reflecting a number of factors, including increased demand for teachers and improved teacher salaries, enrollment in undergraduate teacher education programs jumped by slightly more than 20 percent between 1985 and 1986, and is expected to reflect an increase of about 10 percent between 1986 and 1987.[10]

Teacher applicants are coming from a wider pool than just the recent graduates of education programs, however. Teaching is attracting diverse populations, including many reentering teachers. Data from the American Federation of Teachers' survey of States show that 53 percent of *new hires* in 1987-88 were reentering teachers.[11] In a recent study of teacher *applicants*,[12] school districts reported that about 50 to 60 percent of their applicants for teaching positions are "recent college graduates," 10 to 20 percent are "former teachers trying to get back into teaching," 10 to 20 percent are "substitute or part-time teachers seeking full-time teaching positions," 2 to 5 percent are "mid-career changers seeking teaching jobs," and 2 to 5 percent are retirees wanting to become teachers.[13]

Many States have created special programs to recruit and train new teachers in the areas of mathematics and science. Three approaches are in use.[14] Two types of programs recruit professionals (retirees or career changers) who may be interested in teaching. Some programs provide the coursework required for full certification, while others (known as alternative certification) establish less restrictive criteria for the teaching credential. A third type of program recruits teachers who are currently teaching other subjects and gives them the courses they need

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[4] See Iris R. Weiss, *Report of the 1985-86 National Survey of Science and Mathematics Education* (Research Triangle Park, NC: Research Triangle Institute, 1987).

[5] Jamie B. Draper, Joint Committee for Languages, *State Activities Update: Focus on the Teacher* (Yonkers, NY: American Council on the Teaching of Foreign Languages, December 1988).

[6] By the year 2000, one-half of the student population will be made up of Blacks, Hispanics, and members of other minority groups. In many school districts, especially urban districts, this is already the case. The Task Force on Women, Minorities, and the Handicapped in Science and Technology, "Changing America: The New Face of Science and Engineering," unpublished interim report, 1988.

[7] Martin Haberman, "More Minority Teachers," *Phi Delta Kappan*, vol. 70, No. 10, June 1989, p. 773.

[8] Lynn Olson, "Education Schools' Enrollment Rises for Third Straight Year, Study Shows," *Education Week*, vol. 7, No. 26, Mar. 22, 1989, p. 7.

[9] Carnegie Forum on Education and the Economy, *A Nation Prepared: Teachers for the 21st Century*, The Report of the Task Force on Teaching as a Profession (New York, NY: 1986), p. 26.

[10] Olson, op. cit., footnote 8.

[11] American Federation of Teachers' Survey, cited in C. Emily Feistritzer, *Teacher Supply and Demand Surveys 1988* (Washington DC: National Center for Education Information, 1988), p. 7.

[12] Ibid.

[13] Ibid.

[14] For more information on these programs, see Linda Darling-Hammond et al., *Redesigning Teacher Education: Opening the Door for New Recruits to Science and Mathematics Teaching* (Santa Monica, CA: Rand Corp., Center for the Study of the Teaching Profession, 1989).

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to obtain certification in mathematics and science. Of those graduating from all three alternative programs, 85 percent enter the teaching profession immediately after graduation, and about 75 percent stay in the classroom at least 2 years. Both percentages are comparable to those for graduates of traditional teacher preparation programs. Sixty-four of these programs provided about 10 percent of new science and mathematics teachers in 1986-87.[15] These nontraditional programs also appear to be attracting substantially more minority candidates than other teacher preparation programs.[16]

What Role Can Distance Learning Play in Matching Educational Needs and Available Teachers?

Distance learning provides a way to overcome field-specific teacher shortages by offering classes taught by fully qualified teachers. Because today's technology makes it possible to bring a teacher from any distance to the school electronically, sharing teachers among schools, once a geographic or physical impossibility, is now feasible. For example, **in a recent survey of shortages in foreign language teaching, 38 percent of the States reported that they now offer foreign language instruction via technology (most commonly satellite-delivered courses) as one solution.**[17]

Distance learning can do more than fill the gaps in an uneven teaching supply. It can allow student teachers to observe and work with outstanding teachers—"electronic mentors"—anywhere in the country. It can provide a way to keep teachers up-to-date or to develop expertise in new areas. It can facilitate the preparation of new teachers from nontraditional sources. And it can bring new resources to enrich the classroom environment, create opportunities for team teaching, and open up the walls of the once-isolated classroom.

IMPLEMENTING DISTANCE LEARNING: CLASSROOM CONSIDERATIONS

The Need for Teacher Involvement

If distance learning is to take hold, teachers must be involved in the planning of these systems, trained to use the tools they provide, and given the flexibility to revise their teaching accordingly. Some school reformers and technology zealots have eagerly embraced technology as the new educational fix, an all-purpose solution to the educational ills that beset America today. Those responsible for running the Nation's schools typically take a more conservative, long-term view of change. The physician's "First, do no harm" may be the unspoken watchword of school administrators looking at alternatives to the present system. One requirement for constructive change is the involvement of those who will be left holding the reins—the teachers.

Distance learning, like most technological solutions, may instill initial skepticism and apprehension among parents, students, and teachers. Like the introduction of computers, some of this apprehension subsides once the technology becomes "demystified." When teachers develop experience and an understanding of how to complement their own teaching, their outlook changes. With familiarity, they look at technology as another teaching tool.

But teachers are aware that some schools may try to take educational shortcuts by buying into distance learning courses as a way of reducing staff. Teachers also worry about the quality of instruction students will receive if distance learning systems are not well planned. **Teacher concerns must be factored into any planning for distance learning.** The National Education Association has taken a strong stand on this issue:

> The committee believes that the Association and its affiliates should be involved in the planning, implementation, and evaluation of long distance learning proposals and programs to provide students the highest quality learning experience.[18]

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[15] Ibid., p. xiv.

[16] Overall, 20 percent of the nontraditonal recruits are minority group members; 10 percent are Black. By comparison, the 1985 Survey of Recent College Graduates found that only 9 percent of all bachelor's and master's degree candidates newly qualified to teach (in all subject areas) were minority group members; 5.6 percent were Black. U.S. Department of Education, Center for Education Statistics, May 1986, cited in Darling-Hammond, op. cit., footnote 14, p. 49.

[17] Draper, op. cit., footnote 5, p. 2.

[18] National Education Association Special Committee on Technology, "Policy Statement on Technology," unpublished document, July 1989, p. 7.

Some teachers fear that they will be replaced by teachers beamed in from afar, in a Star Trek vision of the future. Interestingly, this concern diminishes in schools that have used distance learning technologies; those teaching in distance learning projects are adamant in their feeling that teleteaching will not replace regular teachers.[19] Other teachers are concerned that they will be forced to teach over these systems. A more realistic concern is that teachers will be given distance learning responsibilities as an add-on to their regular teaching, with no allowance for the demands of this new role. There is some basis for this concern. **Teleteachers (those who teach a course over distance learning systems) consistently report that it takes them more time to prepare for distant teaching lessons, and more time for followup with students.** For example, in the OTA case studies,[20] despite the varying systems, most teachers strongly agreed that preparing lesson materials for distant teaching is much more time-consuming than preparing lessons for regular teaching. These teleteachers estimated that preparation of a typical daily lesson ranged from 38 minutes up to 4 ½ hours. Yet, despite the increased preparation time, fewer than one-half of the teleteachers surveyed in the OTA case studies received a higher salary for teaching a telecourse than they would in a regular classroom, and 87 percent were not given a reduced teaching load.[21]

Some districts that have not involved teachers early on have experienced labor-management difficulties. Unions representing teachers want to ensure that teacher employment and responsibility levels do not decrease after the implementation of a distance learning network.[22] When faculty feel they do not have enough input into the planning, implementation, and uses of distance learning systems, the result can be frustration, confusion, and potentially less effective use of any system.[23]

When teachers are involved in the development of distance learning systems they have been able to shape the systems to assure appropriate and high-quality instruction and to help planners consider a broader range of services for the entire school community. More importantly, this planning can contribute to a rethinking of staffing requirements and alternative educational arrangements as part of school restructuring efforts. There has been little research on the issue of how distance learning can affect staffing, or how new or desirable teaching models can be utilized, but alternative staffing arrangements and flexibility in collective bargaining issues can be negotiated. Several new possibilities could be considered.

- **Part-time or reduced load teaching assignments.**

Teachers who are at home with young children, or have retired or left teaching for other careers may wish to keep their hand in teaching on a part-time basis, specializing in distant teaching. For example, in Houston's Region IV Interact system, the 11 instructional television teachers are recruited from 3 alternative sources of public school teachers: retired teachers, teachers not currently employed full time in secondary teaching assignments, and full-time university graduate students who hold teaching certificates.[24]

- **Using master teachers or subject area specialists for some or all portions of a distance learning course to supplement the skills of the home-site classroom teacher.**

In one example, a high school in New York State offered Russian history using faculty from a nearby university via distance learning.[25] The classroom facilitator was a history teacher who lacked the special qualifications to teach Russian history. The teacher took the course along with his students, collaborated with the teleteacher throughout the course, and was able to teach the Russian history class himself the following year. Distance learning did not displace this teacher; instead, it expanded his skills and areas of expertise, increasing his teaching options.

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[19] See Bruce Barker, Texas Tech University, "Distance Learning Case Studies," OTA contractor report, May 1989.

[20] Ibid.

[21] Ibid.

[22] See for example, New York State United Teachers, Division of Research and Educational Services, *Survey of Distance Learning Projects*, No. 868718 (Albany, NY: June 1987).

[23] New York State Legislative Commission on Science and Technology, *Distance Learning: The Sky's the Limit* (Albany, NY: September 1988), p. 26.

[24] Barker, op. cit., footnote 19.

[25] Center for Learning Technologies, *Emerging Technologies: Distance Learning*, The Learning in New York Teleconference Series (Albany, NY: Department of Education, Feb. 2, 1988).

- **Employing student teachers, retired teachers, or paraprofessionals as classroom facilitators.**

Here, too, the unique cooperation possible between the teleteacher and the teacher in the receiving site makes it possible to combine the skills, expertise, and experience of different levels of teaching. In many distance learning projects, the teleteacher is a uniquely skilled teacher; a teaching intern could learn a great deal by working with these teachers as a site facilitator. Conversely, a retired teacher serving as a classroom facilitator could bring experience and perspective to enrich the distance learning course.

- **Sharing teaching among several teachers within a distance learning course (see box 4-A).**

Opportunities exist for creating new interdisciplinary courses, combining the expertise of several teachers from many schools. A district could offer a course in "Major Issues of the 20th Century," highlighting the teaching of a top-notch history teacher from one school, the literature teacher in another, and science and technology experts from other schools. Teachers might welcome the opportunity to participate in special courses if each could focus on those topics in which they have special expertise and interest, working with distant colleagues whose expertise complements their own.

In the traditional classroom, one of the barriers to team teaching has always been scheduling. In distance learning, scheduling adjustments, while difficult, are accepted as the norm. In cooperative distant teaching, changing concepts of time and place can make team teaching more feasible. The class environment can remain the domain of the home school teacher, but it can be expanded by sharing teaching resources with colleagues.

Distance Learning Technologies and Teaching Style: Issues of Interaction and Instructional Design

Clearly, distance learning can add new resources to the traditional classroom, whether those resources are specialized teachers or contributions from wise and unique people from many walks of life. These resources will change the design of courses and how teachers conduct their classes. In fact, many teachers develop new skills and insights that carry over into their regular classrooms.[26]

Students, teachers, course material and presentation, and interaction are all affected; distance learning creates a new context within which the education process and student-teacher interaction take place. Old styles of teaching and learning may not be most appropriate or effective when mediated by telecommunications technologies. These technologies impose inherent limitations (which vary by individual technology), but they can also enhance the learning process.

In attempting to incorporate distance learning into a classroom setting, or in designing distance courses or modules, teachers and instructional designers have had to find ways to restructure interactivity. Various types of distance learning systems may limit interaction in different ways. Some systems, such as audiographics, do not permit students and teachers to see each other, but they can converse and exchange written materials, sophisticated graphics, and visual images. And use of the graphics tablet can be very effective in courses such as astronomy and calculus. This interaction, while not face-to-face, may be equally effective.

In one study[27] looking at several projects using audiographics systems, teleteachers confirmed that the preparation required for audiographic presentation forced them to rethink the design of their courses. Many commented that the lack of visual contact with their students forced them to improve their communication and listening skills.

> Regardless of whether they changed teaching styles, virtually all instructors claimed they were better teachers after teaching even one course over the audiographic system. They attributed this to the fact that they had to be much better prepared than in the traditional environment. They began to think more systematically about what they were teaching and how best to present the information in spoken

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[26] Barker, op. cit., footnote 19.

[27] Kay W. Gilcher and Sally M. Johnstone, *A Critical Review of the Use of Audiographic Conferencing Systems by Selected Educational Institutions* (College Park, MD: International University Consortium, University of Maryland, 1988).

Box 4-A—Team Teaching Over a Two-Way Video Link[1]

During the 1988-89 school year, two high schools in the Hartford area piloted a two-way video and audio hookup over the local telephone system. This demonstration project was funded by the State of Connecticut and Southern New England Telephone (SNET). Bulkeley High School in inner-city Hartford was linked with Hall High School in suburban West Hartford. A teacher at each school volunteered to participate in the first pilot run of the compressed video system and to explore applications for teaching advanced Spanish in their districts.

Why were the two teachers in these high schools eager to participate? Mary Foley, Hall High School teacher, wanted to join the two classes in order to expand her students' cultural understandings and enrich their course content. She felt that her students would benefit from experiences that prepared them for learning and working with people from many different walks of life. And although her students were "advanced" in Spanish, they were not fluent speakers. Bulkeley's students, many whose first language was Spanish, had much to contribute. For Bulkeley High School teacher John DiPietro, the project ". . . provided an opportunity for others to learn about us, and us about them."

The two teachers spent many hours working together, preparing to team teach their advanced Spanish courses (one Advanced Placement, the other designed for native language students with high levels of fluency). They found common ground, despite a contrast in their teaching styles, curriculum emphasis, backgrounds of their students, and classroom facilities.

The first day of team teaching started with both classes coming together for a joint class held at Bulkeley High School. The day was an exciting one; officials cut the ribbon at the door of the electronic classroom at the high school and the technology links between the sites were turned on. The classes met in a roundtable forum, conversing in Spanish, while district, State, school board, and telephone officials watched. Teachers felt that this first "face to face" meeting was essential. The classes teamed for 1 week during the spring 1989 pilot, and will continue on a regular basis in the fall. In addition, the two-way classroom link will be used to offer a new course in Italian from Bulkeley to Hall, adding curriculum resources that neither school had offered before.

How will this joint project influence other efforts in the State? According to Betty Sternberg, State Supervisor for Curriculum and Instruction, this project will help educators understand the strengths and limitations of distance learning. She is cautious about the benefits: technologies alone cannot resolve differences in educational resources. "Let's not kid ourselves, technologies are not educational panaceas." Nevertheless, State Commissioner of Education Gerald Tirozzi believes that these efforts can open up thinking about sharing teachers and resources across districts.

From the SNET point of view the project will help telephone companies learn how students and teachers can use telecommunications, what technical changes are needed to make the system work better, and what creative applications are possible. As Kathy Buccy, head of the SNET Links to Learning Project notes: ". . . these schools will use our telecommunications resources to serve their needs—two different schools, two different facilities linked by the need to share knowledge."

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[1] OTA site visit, February 1989.

and graphic forms. They stated that this improvement in their teaching carried over into the traditional classroom.[28]

Distance learning teachers have found that, unless they pay close attention to the need to create an interactive environment appropriate to the technology, students can and will tune out. One study suggests:

> The best way to learn new information is to receive it while in an active, rather than passive, state of consciousness . . . .One simple method the instructor can use to assist the learner . . . is to do something that is never done on broadcast television: to talk directly to the distant learner and require a response at the very beginning of the session.[29]

In another project, instructors show a short videotape during the first class session that high-

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[28] Ibid., cited in *American Journal of Distance Education*, vol. 3, No. 1, 1989, p. 82.

[29] Sally M. Johnstone, "Interactive Teaching: Breaking Television Viewing Habits," *ED, The Distance Education Network Report*, vol. 2, No. 5 (San Ramon, CA: Applied Business Telecommunications, May 1988), p. 4.

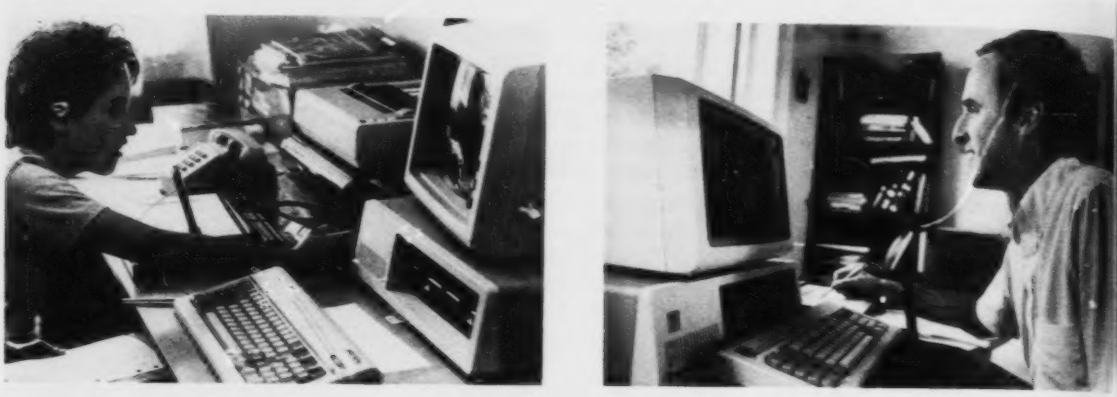

Photo credit: John Hubbard, Colgate University

Teacher and student, though miles apart, work together on a mathematics problem over this audiographics system.

lights the difference between recreational viewing and interactive instruction via television.[30] When teachers help their students prepare themselves for active viewing of media, the students are more likely to overcome the passive habits acquired from recreational use of media.

Teaching in a distant learning setting challenges teachers to rethink their interaction with students. Even in the traditional classroom, interaction between teacher and student does not just happen—good teachers are always looking for ways to involve their students. Furthermore, student learning comes not just from interacting with the teacher; it comes from interacting with other students, and relating new information to prior understanding and knowledge. The distance learning teacher must deliberately structure opportunities that encourage students to work together in small groups, tackle problems on their own, or work with materials like computer programs to test and reinforce learning when the teleteacher is not available.[31] In these instances, the local facilitator can play an important role. Both the teacher and facilitator function as instructional guides or coaches, to explain, answer questions, and go into greater detail. With less opportunity for traditional forms of interaction, students may have to take more responsibility for their own learning.

Because of the physical separation between the teacher and students, teleteachers need to establish ways for students in the remote classrooms to feel comfortable contacting them. These arrangements vary with the type of distance learning project, the technology used, distances, and the number of students involved. They include:

- meeting in person with students in each of the distant classes early in the course;
- arranging for all the students to meet together at least once, ideally at the beginning of a class;
- asking students to send in pictures of themselves to personalize their responses to questions on the air;
- having telephone office hours when students can call and discuss the lessons with them, or with teaching assistants;
- setting up assignments for students to handle as members of learning groups;
- using electronic keypads to gauge student understanding during the lesson, allowing the teacher to assess if the material is understood before moving ahead in the lesson; and
- assigning computer activities that give students the opportunity to move along at their own pace, with feedback enabling the teacher to assess each student's strengths or trouble spots.

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[30] Rich Gross, Dean of Telecommunications, Kirkwood Community College, Cedar Rapids, IA, personal communication, July 1989.

[31] Barker, op. cit., footnote 19. See also Toby Levine, Communications, Inc., "SERC Pilot Semester Evaluation Project," report prepared for Satellite Educational Resources Consortium, Columbia, SC, July 1989.

Photo credit: Sandy Welch, Kentucky Educational Technology

In some satellite courses, students send answers instantaneously via electronic keypads. Teachers know at once who needs additional help.

Teleteachers interviewed in the OTA case studies[32] were concerned that distance made one-on-one communication more difficult. In systems that had no immediate visual feedback, teachers missed being able to read their students' visual cues and nonverbal behavior. These negative features created by the technology should not be minimized. **One of the main reasons many teachers chose teaching and remain in the position is the satisfaction they derive from working closely with individual students, listening to their problems, and observing and guiding them in their personal and social development as well as academic growth, both in and out of class.**[33] The implication for distance learning efforts is important. **Not all teachers want to teach at a distance**, especially if the distance learning system is one in which they teach to an empty studio and have no classroom that is their "home class," or in systems where all students cannot immediately reach them with questions and comments. It is easier to maintain interpersonal relationships between students and teachers in systems where the distance learning teacher maintains a home classroom and extends his or her reach to students in distant classrooms, while limiting total student enrollment to that found in a typical class.

What Skills Do Teachers Need To Teach Via Technology?

The key to any distance learning system is the teacher. Not every teacher makes an effective teleteacher. As suggested by one researcher:

> Just as every person in the world is not born to be a teacher, every teacher is not born to be a teleteacher. Being a good teleteacher calls for all of the understanding, experience, and skills of a live classroom teacher—and lots more. A good voice; pleasing appearance; stage presence; plenty of self confidence; a flair for the dramatic, artistic, creative; being comfortable with the use of the technology; and a willingness to go the extra mile are all vital qualities. Most important is an openness to becoming comfortable with the new technology and an ability to use its strengths to enhance teaching and learning.[34]

More is required, however, than just these personal attributes. **The critical role of the teacher in the distance learning setting makes it imperative that teachers get adequate training not only in the technical aspects of the system, but also in the educational applications of the technology.** Teachers' understanding of how to design a course and of appropriate and effective communication skills for teaching at a distance are central to the success of the effort. These are also the lessons they will most likely carry with them back to the face-to-face classroom environment.[35]

Many teachers have asked for more training on how to use distance learning systems most effectively. For example, faculty members in the Learn Alaska Network requested preparation for distance teaching, identifying the need for assistance in such areas as:

- the amount of time needed to prepare and teach distance delivered courses,
- methods to establish and maintain effective communication with distant students,
- experiences of other faculty members,

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[32] Barker, op. cit., footnote 19.

[33] For example, one study found that the majority of teachers (70 percent) discuss personal interests or hobbies, current events, and personal problems with their students outside the classroom. And, when the relationship between teachers and students is described as positive, teachers are more likely to be perceived as "excellent" teachers; students listen more often in class, and students' performance and enthusiasm for learning are higher. Louis Harris & Associates, Inc., *The Metropolitan Life Survey of the American Teacher 1988* (New York, NY: 1988), p. 8.

[34] Dean Bradshaw, *The Promise of Distance Learning* (San Francisco, CA: Far West Laboratory for Educational Research and Development, January 1989), p. 22.

[35] Gross, op. cit., footnote 30.

- strategies for adding visual components to audio courses,
- strategies for increasing interaction both among students and between students and faculty,
- planning and management of organizational details involved in distance delivery, and
- strategies to encourage group cohesion and student motivation.[36]

Unfortunately, many projects throw their teachers into distance teaching assignments with little preparation. One study suggests:

> With only a few exceptions, the best training is little more than a quick effort at the last moment before implementation or after problems have already appeared. Often teachers are left to grapple with the new programs on a "sink or swim" basis under the assumption that no training is required.[37]

In OTA's seven case studies,[38] nearly two-thirds of the teleteachers surveyed (64 percent) had not received training prior to teaching over their respective distance learning systems.

All the large multistate distance learning projects have, however, addressed the training of both distant teachers and facilitators. Some projects give prospective distance teachers screen tests. For example, in the STEP network, despite the fact that teleteachers are certified high school teachers who have extensive teaching experience, they all receive instruction in communication skills for presentation over television. The training is provided by the private broadcast studio from which STEP programming originates. As the general manager of the studio said:

> You can't just walk in front of a camera and start to talk. Our major role is integrating the teachers' teaching skills with the broadcast medium. The producer and director show them how to use the set, how to move across the set. We emphasize the importance of maintaining eye contact with the camera and projecting an image that personalizes their instruction to the students. We don't want any of the broadcast or teaching of the teacher to look clumsy. The students will recognize clumsy programming and judge the quality of instruction accordingly . . . .We want the student to see that the teacher looks smooth, comfortable, under control, and professional in front of the camera.[39]

Many teachers are natural actors. The classroo is their stage. For them, communicating in front o a camera may not be so different. But teleteacher must learn how to use the resources provided by th distance learning system creatively to communica with their students, however far away they may be

Research on collaborating in the workplace and i "virtual classrooms" (educational communities sep arated in time and place), suggests new opportunitie for learning and different communication meth ods.[40] In research on computer-supported coopera tive work, research focuses on creating virtua environments similar to human communities an facilitating emotional bonding and social relation ships over distances. The major applications devel oped so far use video imaging and digital voice t widen communication as much as possible, so tha users can transfer face-to-face interaction skills int the new environment. **However, while many as pects of virtual environments are similar t face-to-face encounters, the overall communica tion style needed to be effective in electroni interaction is different.**

The interchange of ideas in distance learnin requires different communication methods than i conventional classrooms for a number of reasons:

- information technologies are predominantly visual medium, rather than the textual an auditory environment of the conventiona classroom,
- the affective content of technology-mediate messages is muted compared to face-to-fac interaction, and
- complex cognitive content can be conveye more readily in electronic form because multi

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[36] See Michael Moore, Pennsylvania State University, "Effects of Distance Learning: A Summary of the Literature," OTA contractor report, May 19 p. 23.

[37] Anne Batey and Richard N. Cowell, *Distance Education: An Overview*, ERIC, ED 278 519 (Portland OR: Northwest Regional Educa Laboratory, 1986), as cited in Moore, op. cit., footnote 36, p. 22.

[38] Barker, op. cit., footnote 19.

[39] Jason Vingelen, RXL Communications, Spokane, WA, personal communication in Barker, op. cit., footnote 19, p. 12.

[40] For a fuller discussion of this concept, see Christopher Dede, University of Houston-Clear Lake, "The Evolution of Distance Lea Technology-Mediated Interactive Learning," OTA contractor report, July 1989.

ple representations of material (e.g., animations, text, verbal descriptions, and visual images) can be presented to give learners many ways of understanding the fundamental concept.[41]

Training is also an integral part of distance learning projects that are intended as supplements to, rather than substitutions for, regular classroom teaching. The training that is given to the classroom teacher who is responsible for implementing these activities and lessons in the classroom varies with the depth, sophistication, range, and, perhaps, novelty of the enrichment materials. For example, in programs presented by the Public Broadcasting System, the National Aeronautics and Space Administration, and Talcott Mountain Sci-STAR, advance materials help teachers prepare for the series with their students. Suggestions and materials for followup activities are often provided as well. Other projects take a more intensive training approach to prepare teachers for an instructional approach that will be different. The Technical Education Research Centers (TERC) Star Schools Project involves the use of electronic databases for students to record, analyze, and compare scientific data they have collected in their communities. This "hands on" teaching approach to science and technology may be novel to many teachers. TERC staff believe that teaching with databases and telecommunications is new to most teachers and thus teacher training and ongoing support is central to the success of the project.

The Role of the Classroom Facilitator

Although the role of the classroom facilitator varies across distance learning projects,[42] training is important if this individual is to be more than a "babysitter" for the students in the receiving classroom. Many projects take a hit or miss approach to facilitator training, despite the fact that this new position offers opportunities to enhance learning for students in the remote classroom. The facilitator is usually responsible for operating the receiving equipment, monitoring student behavior, evaluating or distributing homework and materials, supervising testing, and assisting with educational activities as assigned by the teacher.[43] **Under ideal circumstances, the distant teacher and facilitator work as a team.**[44] Before classes start they meet (in person or electronically) to discuss the teacher's goals for the class, instructional techniques, and, most importantly, how the facilitator can contribute to the students' learning experience. For example, in some cases, facilitators allow students in receiving sites to discuss and explain points to one another during class, with the talk-back microphones turned off. This peer tutoring can greatly enhance learning without disrupting the rest of the class in other sites; it is an example of structuring the situation to encourage alternative learning. This would be difficult to manage in traditional classroom settings.

DISTANCE LEARNING AND THE PREPARATION OF NEW TEACHERS

Despite the fact that teacher improvement has been a major issue in recent school reform efforts, schools and departments of education are not well funded; and, many are not well respected. Even though there are some encouraging signs that the number of students entering education programs is slowly rising[45] and that their quality is also improving,[46] the teacher education programs are still of mixed quality.

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[41] Ibid., p. 14.

[42] Some distance learning projects do not involve classroom facilitators. In these projects, no teacher or other adult is present in the remote site with the students, although a video monitor in the principal or counselor's office may be used to keep an "eye" on the students. In these projects, distant teachers develop a different instructional approach, requiring increased student responsibility for their learning. See Minnesota Department of Education, *Interactive Television Teaching* (St. Paul, MN: 1988).

[43] Bradshaw, op. cit., footnote 34, p. 23.

[44] A study of multiple classes taking a German-by-satellite course found significant differences in the role of facilitators in the receiving sites. These differences corresponded with student success in the course. Students were consistently most successful in those sites where the facilitators had responsibility for coordination of and assistance with software use, watching all broadcasts with the students, encouraging student interaction with the instructor, learning German along with the students, troubleshooting equipment, answering or finding answers to simple student questions, providing additional quizzes or worksheets, solving individual problems, and assisting with use of the modem. The facilitators in these sites were also much more likely to have received training in operation of the equipment and software use. Vicki M Hobbs and Donald D. Osburn, *Distance Learning Evaluation Study Report II: An Inter- and Intra-State Comparison* (Denver, CO: Mid-Continent Regional Education Laboratory, 1989).

Almost every State has taken steps to alter the education of teachers.[47] The reforms include higher standards for admission, improvements in the teacher preparation curriculum, and requirements that prospective teachers pass tests of subject matter or professional skills as prerequisites for initial certification. Leading education professionals are developing a broad agenda for improving the profession, taking as their charge the goal of enhancing the intellectual underpinnings of teacher education while simultaneously improving the profession.[48]

Educators today have also come to appreciate that computers, videodiscs, and other technologies should be basic tools of the teaching trade; nevertheless prospective teachers are not necessarily trained in their use.[49] Although over one-half the States require or recommend technology training for teachers prior to certification, many schools and colleges of education are still struggling to find ways to train teachers to use computers as a general teaching tool.[50] **As difficult as the problem is with computers, even fewer programs prepare teachers for assignments that go beyond the four walls of the classroom.** Few education school faculty are experienced in the use of new technologies, and few universities tie such training into educational methods courses. In one survey[51] of schools of education and teacher training programs (undergraduate and graduate) examining the extent to which future teachers and administrators are trained in distance education technologies, 84 percent of the institutions surveyed offered training in the instructional use of computers, 64 percent in the instructional use of video, and 55 percent in the instructional use of audio technologies. These courses dealt primarily with the use of equipment. Only 52 percent of the institutions offered training in the management of small groups of students using computers, 37 percent offered instruction in the use of live interactive television for instruction, and only 26 percent offered courses in the use of audio technologies in instruction. Fewer than 20 percent of institutions required this instruction for teachers.

Because of the rapidly changing nature of distance learning technologies, it is not possible to try to prepare students for all the situations that lie ahead. There are, however, some examples of teacher preparation programs in which prospective teachers are trained to understand the distance learning experience. In some cases, distance learning systems help prepare teachers for classroom work.

At Mansfield University in Mansfield, Pennsylvania, education students taking an elective course in instructional technologies use audiographics to teach students in Riverdale, North Dakota.[52] Computer screens prepared ahead of time can accompany lessons, as can pictures, charts, outlines, or other visuals sent live from the student teacher's computer to the distant sites via high-speed scanner technology. Students in the participating Riverdale classrooms send written or graphic responses via computer and talk to their student teachers via telephone. Riverdale, which has no teacher education institutions nearby, welcomed the opportunity to expand their curriculum with the mini lessons presented by the distant student teachers. The project makes it possible for prospective teachers to develop student teaching experience early in their education program, and to learn about distance learning technology through direct practice.

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[45] Olson, op. cit., footnote 8.

[46] Indicators of quality of prospective teachers are mixed. One survey noted that the typical teacher education student is in the top one-third of his or her high school graduating class. American Association of Colleges for Teacher Education, *Teaching Teachers: Fact & Figures* (Washington, DC: 1987). Nevertheless, other indicators, while showing improvement, still give reason for concern. For example, although the average SAT scores of high school seniors intending to major in education have risen in the last 2 years, this slight gain follows a period of over 10 years during which scores of prospective teachers declined at a faster pace than the drop experienced by all college-bound students, and a wide gap remains between prospective teachers and all other college-bound seniors. Carnegie Forum on Education and the Economy, op. cit., footnote 9, pp. 31-32.

[47] "A Survey of Two Years of Action by 50 States and D.C. to Reform the Education of Teachers," *The Chronical of Higher Education*, Apr. 20, 1988, p. A31.

[48] See The Holmes Group, op. cit., footnote 1.

[49] U.S. Congress, Office of Technology Assessment, *Power On! New Tools for Teaching and Learning*, OTA-SET-379 (Washington, DC: U.S. Government Printing Office, September 1988).

[50] Ibid., p. 102.

[51] J.A. Riccobono, *Instructional Technology in Higher Education: A National Study of the Educational Uses of Telecommunications Technology in American Colleges and Universities*, ERIC, ED 278 369 (Washington, DC: Corporation for Public Broadcasting, 1986).

[52] Barker, op. cit., footnote 19.

Classroom Observation for Education Students Via Distance Learning

A major focus in the reform of teacher education is the clinical teaching experience. Observation and analysis of classroom practice prepares future teachers for more extensive teaching and clinical experiences. However, many teacher preparation institutions lack the ability to provide a variety of early observation opportunities. Distance learning technologies can fill this gap. (See box 4-B.)

Electronic Networks Linking Student Teachers

Another way distance learning technologies can improve the preparation of new teachers is through the use of computer networks to link education schools and novice teachers during their first teaching experiences. These networks provide an on-call help line, a resource that education faculty, supervising teachers, and beginning teachers find valuable for asking questions, solving problems and minimizing the sense of isolation many new teachers feel. (See chapter 1, box 1-C.)

Other education schools are establishing networks to communicate with student teachers as well as recent graduates. Iowa State University has a network for student and first-year teachers and new public school administrators, partially supported by Apple Computer. The Harvard Graduate School of Education's Beginning Teacher Network links 50 of Harvard's newest graduates with one another and several faculty from the School of Education. Information sharing, professional advice, and support for the new teacher in the difficult first year of teaching are the goals of the network.[53]

RESOURCES FOR THE ONGOING PROFESSIONAL DEVELOPMENT OF TEACHERS

Distance learning technologies are being embraced by many school districts as valuable resources for the entire school staff, not just the students. Staff support via distance technologies ranges from breaking barriers of isolation via electronic networks to the offering of graduate degrees. A sampling of these activities include:

- support over networks linking teachers and other school staff (e.g., librarians, counselors, and principals) to their colleagues;
- live teleconferences or video conferences using open audio lines (e.g., AIDS information meetings and State education association annual meetings);
- short courses on content or pedagogy based on new research or newly available materials;
- full courses to meet recertification requirements, change teaching specialties, or earn advanced degrees; and
- any variations and combinations of the above.

The major advantages provided by the distance learning technologies are the same for teachers as they are for students: expanded curricular access, opportunities to interact with top quality instructors, and opportunities to take classes without having to travel. Yet different factors come into play in the training of adults than in the training of children, and it is these factors that make analogies to business training appropriate. **Schools are beginning to use technology in much the same way as businesses—as an efficient means of providing professional development.**

Much of the literature on distance learning effectiveness has dealt with the training of adults via distance learning technologies.[54] That is not surprising since most of the use to date has been in higher education, business, and military training applications. The factors contributing to the success of distance learning involving college students, businessmen, and army personnel also make distance learning effective for teachers. In training adults, there is less concern about the physical absence of the teacher. Teachers, like other adult professionals, have the maturity, attention span, motivation, and discipline to succeed in the somewhat unusual distance learning environment.

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[53] See Office of Technology Assessment, op. cit., footnote 49, p. 104.

[54] See ch. 2.

Box 4-B—Guided Observation: Iowa Teachers on Television[1]

At Iowa State University (ISU), student teachers observe exemplary teaching in diverse classrooms across the State, without leaving the campus. The Teachers on Television (TOT) program, which received a 3-year (1985-88) grant from the Fund for the Improvement of Postsecondary Education (FIPSE), is now in its fourth year of operation. The TOT project addresses two concerns in teacher education: preparing preservice teachers to become competent observers of teaching and learning environments, and providing a diversity of high quality introductory observation experiences to teacher candidates regardless of their location. TOT was designed to address these issues by using remote structured observations, supplemented with course material that shows the education students the relationship of pedagogical theory to real life teaching practice.

The TOT program uses live microwave television broadcasts that are remotely controlled via telephone from an observation site at Iowa State University at Ames. Classroom teachers are chosen for their diversity in grade level, curriculum materials, teaching style, and educational philosophy. All are exemplary teachers. Each observation classroom has a camera mounted on a pedestal with remote pan, zoom, and tilt features. The audio is mixed with the video signal and returned to ISU via microwave. The receiving site at ISU is equipped with a large video screen, multiple telephones, a control panel, a broadcast camera, and mixing equipment to overlay the facilitator's comments onto the classroom signal.

Prior to each broadcast, the participating classroom teacher supplies information about the instructional setting (e.g., lesson plans, student work, floor plan, teaching philosophy). An ISU education school faculty member serves as the facilitator, maintains regular contact with teachers, and interprets the class activity during the broadcast, shown in a second window in the television picture. The facilitator's role is to bridge education theory with actual teaching practice. At the end of each broadcast sequence, a followup interview with the teacher allows for discussion of what happened, identification of successes and problems encountered, and future classroom plans. Education students are able to observe TOT classrooms live on a drop-in basis at one of two classroom sites, or via videotape at their convenience.

Evaluation of the original FIPSE project focused on the impact of the TOT program on sophomore preservice teachers' attitudes and abilities to recognize effective teaching behaviors, and found positive outcomes in both areas. Students were enthusiastic about the experience, especially the opportunity to observe real classes on a regular and convenient basis, and to go back over certain portions of an observation with the use of the videotapes. Curriculum materials helped guide their observations. Some of the best teachers in the State were available to every education student at ISU without interrupting their work. The partnerships formed between the participating schools and the education school faculty also created an unusually high level of university/classroom collaboration leading to joint research projects, curriculum revision, and national presentations. Classroom teachers enjoyed the challenge of being role models for a new generation of teachers and found that teaching on television provided an opportunity for professional growth and statewide recognition while allowing them to remain where they are happiest—in the classroom.

At first, most of the ISU education faculty viewed the TOT project with skepticism. Education faculty lacked time and resources to integrate TOT into their courses. Faculty training and discussions focused on how these new resources could be used effectively. These discussions led to the design of a project funded by the Iowa Department of Education in mathematics and science instruction using teachers from the TOT classrooms and the ISU faculty.

As the project gained acceptance, transmission costs became a critical factor. A university-wide change in telephone service resulted in long distance call rates (Ames to Des Moines) jumping from a 50 cents per day flat fee to an hourly charge averaging $10 per hour and $60 per day. In addition, technical support costs increased when the university television station became a for-profit enterprise, and charges for service, microwave transmission, satellite transmission, and other activities were no longer subsidized. Both these factors made the project more expensive than anticipated.

At the conclusion of the FIPSE grant the project sought to become self-sustaining by developing a national consortium of university subscribers. In 1988-89, there were 7 subscribing institutions, with a long-term goal of 40 participants. Because of economic factors and the difficulties of scheduling broadcasts to other institutions across time zones, the observations are videotaped and mailed to subscribing institutions rather than being offered live over satellite.

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[1] OTA site visit, March 1989.

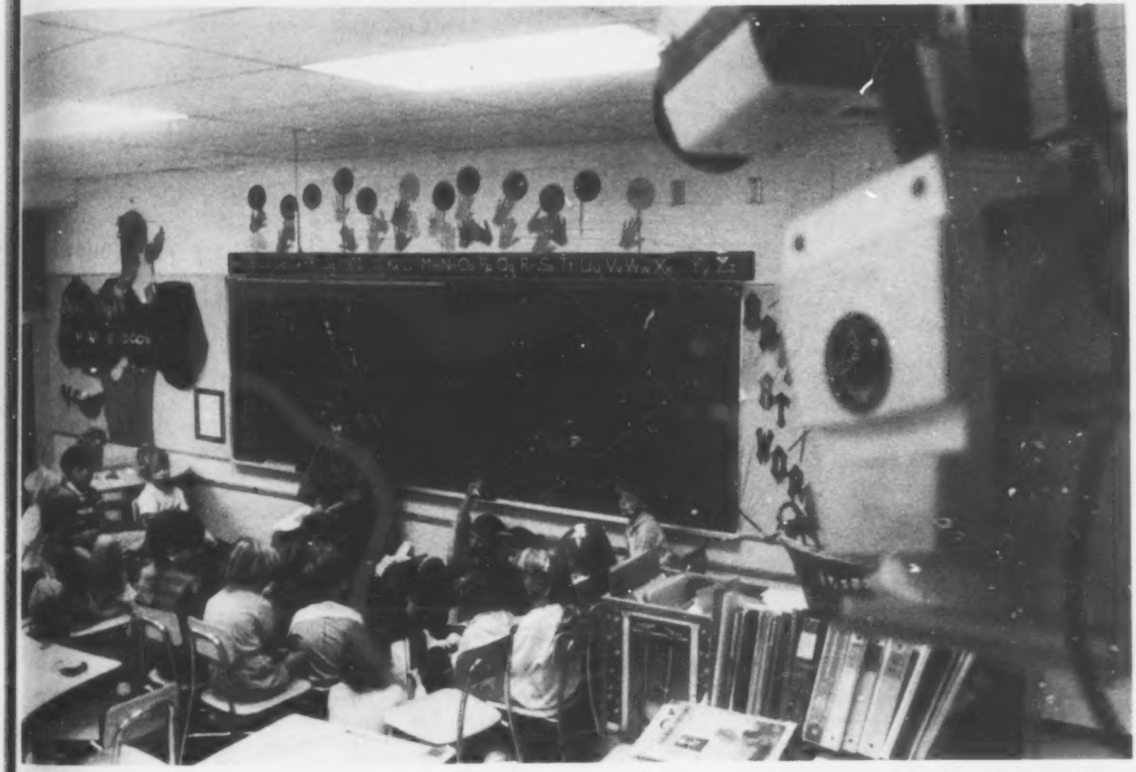

Photo credit: Iowa State University

One of the best ways to learn about teaching is by watching good teachers. Nancy Frazier's second grade class at Fellows Elementary School in Ames is beamed live to education students at the university.

Inservice Training

No nationwide figures reveal the number of teachers who receive staff training via distance learning technologies. However, of the more than 100 distance learning projects entered in OTA's database, one-half include teacher support or training components. Projects in Virginia and California are illustrative.

Through funding from the National Science Foundation, the Center for the Liberal Arts at the University of Virginia (UVA) offered a 14-week chemistry course by satellite to teachers at nine regional classrooms across Virginia.[55] Two hundred sixty-three science teachers, or the equivalent of one-half the chemistry teachers in the State, completed the course. The class was carried live every Saturday morning to the downlink sites, where teachers gathered with their local colleagues. Instructors from local colleges served as on-site facilitators. Each session consisted of 1 hour of live, two-way audio, one-way video lecture/discussion conducted by a UVA chemistry professor, followed by 1 hour of group activity led by the local instructor. During the third hour of each class, videotaped laboratory demonstrations and videotours of university research laboratories were sent via the satellite transmission. In each of the local sites, teachers collaborated on classroom projects, and at the final session each regional classroom presented its most successful project to the other sites via the system. The course also provided participants an advanced level textbook and over 50 printed handouts, which

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[55] R. Bruce Martin, Professor of Chemistry and Associate Director, Center for the Liberal Arts, University of Virginia, Charlottesville, personal communication, August 1989.

Box 4-C—Los Angeles Educational Telecommunications Network[1]

The Educational Telecommunications Network (ETN), owned and operated by the Los Angeles County Office of Education, provides staff development via satellite. Programming is provided at no charge to 62 school districts in the county as well as to 25 other counties around the State. Subscribing counties pay an annual membership fee of $2,000, plus an additional amount based on their average daily attendance count (15 cents per pupil). Subscribers and the districts within Los Angeles county can participate in any of the live telecourses offered over the system, or may record and retain the satellite transmissions for later use. Each series includes leaders' guides and other support materials that can be duplicated and distributed within the participating district or county.

Telecasts for staff development in curriculum reform have been the largest use of the system. From October to May in the 1988-89 school year, ETN broadcast 54 programs dealing with changes in California curricula (28 in English/language arts, 14 in K-8 mathematics and 4 in preparing for mathematics "A" (9-12), and 8 programs on leadership issues for administrators charged with instituting the new curriculum). Publishers of English/language arts and mathematics textbooks sponsored an additional 26 telecasts to review alignment of their texts with the revised curricula. ETN also offered several hours of programming for teachers on such topics as suicide prevention strategies, child abuse prevention, AIDS update, and Hispanic parenting, as well as 4 hours for parents on special education resources. Administrative briefings and special meetings were also transmitted over the system. In addition, 26 hours of instructional television programs were broadcast over ETN for teachers to copy for later use in the classroom.

An advisory committee composed of teachers and assistant superintendents for curriculum and instruction recommend programming priorities, scheduling, key issues, and staff support requirements. Programs are live and interactive; viewers call in their questions and reactions. Some programs have been designed to be interrupted so that participants at local sites can discuss ideas and issues among themselves in the midst of the program, then go back to the presenters with their groups' questions and comments. Presenters also use video footage from classrooms to model the strategies and content being discussed in the telecast.

Of special interest in the ETN model is the use of on-site satellite facilitators who are trained in both technological "know-how" to receive ETN satellite transmissions, and in leading group discussions. The facilitators work with local district content specialists who are trained to answer questions on the content presented and to manage the pre-viewing, telecast, and post-telecast activities, and to organize later followup activities. Facilitators and content specialists receive leaders' guides that contain a summary of the video conference, masters for handouts, suggested optional activities, facilitators remarks, and detailed suggestions for followup activities.

The network resources can serve a broader range of training needs. Under a contract with the Los Angeles County Board of Supervisors, ETN will produce and telecast staff development courses for paramedics, law enforcement personnel, librarians, and social workers in the county.

[1] OTA site visit, February 1989.

included a demonstration handbook and teacher resource guide prepared by the collaborative groups.[56]

The California Department of Education distance learning activities focus on teacher inservice training. This emphasis reflects both the needs of teachers, who must complete 150 hours of staff development during each 5-year cycle as a condition for renewing their teaching credential,[57] and the State mandate for curriculum reform. This curriculum reform in English/language arts, mathematics, history/social science, science, and the visual and performing arts, includes changes in what and how teachers are expected to teach. The Los Angeles Educational Telecommunications Network has been the catalyst for a statewide staff development program that supports and enhances California's curriculum reform efforts.[58] (See box 4-C.)

Many States and localities subscribing to multistate satellite distance learning systems have utilized

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[56] With the second phase of National Science Foundation funding, in January 1990, the center will offer a similar course for middle school physical science teachers. All physical science teachers in the State have been invited to participate in planning the course to meet the needs they deem most urgent. 300 will be selected to participate in the tuition-free, three-credit course. Ibid.

[57] Margaret E. Goertz, *State Educational Standards in the 50 States: An Update* (Princeton, NJ: Educational Testing Service, March 1988), p. 36.

[58] Patricia Cabrera, director/executive producer, Educational Telecommunications Network, Los Angeles County Office of Education, personal communication, July 1989.

Photo credit: ETN, Los Angeles County Office of Education

Facilitators are important to successful distance learning. Here teachers are trained as site facilitators for staff development courses sent via satellite.

the inservice training programs they offer nationwide. Additionally, inservice teacher training is a component of all Star Schools projects. While the number of teachers participating is unknown, the value of access to national experts is clear. As one superintendent said: "To get a Rita Dunn or a Harry Wong [both well-known inservice trainers] here in person, we can spend between $3,000 and $5,000 on a one-day presentation. . . . For $5,000 via TI-IN, we get a whole year of top quality in-service training."[59] As States and districts build their own distance learning networks, or link up with others, applications for teacher inservice and professional development are likely to expand (see appendix A).

Electronic Networks for Linking Teachers

Teacher support of a less formal sort is available through electronic networks for teachers. Several States and districts have developed these systems. One interesting example is Montana's Big Sky Telegraph Network, a grassroots telecommunications system supporting rural educators with electronic mail, computer conferencing, a lesson plan database, and a software loan library.

The Big Sky Telegraph Network links teachers in 114 one-room schools across the State of Montana. This bootstrap effort encourages participation by all persons interested in improving rural education through the computer-assisted sharing of creative ideas and available resources.[60] A one-semester credit course for teachers, "Microcomputer Telecommunications for Educators," is also available on the system. The course objectives are to demystify the telecommunications uses of computers as they relate to K-12 education and to provide needed rural community services through better communications with resource persons, Western Montana College, various service agencies, and other on-line services. The course also aims to develop confidence in computer telecommunications and to encourage continued professional uses for peer networking, resource sharing, and K-12 student/classroom use. The course meets on-line at the learner's convenience for a minimum of 2 hours per week for roughly 20 minutes per call. The location of the course is the ". . . nearest microcomputer to the student's location."[61]

New York State also has an extensive support system for teachers through their Teacher Centers electronic bulletin board, TECHNET, at New York Institute of Technology. This, like other teacher networks, can provide a number of professional benefits by:

- increasing the availability of preservice and inservice teacher training, while realizing often substantial decreases in mileage payments to participants;
- providing the capacity for teleconferencing among the boards of education and staffs of the school districts, thus eliminating or reducing some transportation costs;
- increasing the possibility of interdistrict subject-area departmental meetings that allow for continuous improvement of instruction through the sharing of successful techniques and strategies; and

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[59] John Rinaldi, Chittenden South Supervisory School District, quoted in National School Boards Association, Institute for Transfer of Technology to Education, *The Electronic School*, September 1988, p. A19.

[60] Frank Odasz, Big Sky Telegraph, personal communication, Mar. 7, 1988.

[61] Big Sky Telegraph is funded by grants from the M.J. Murdock Charitable Trust of Vancouver, Washington and the US West Foundation of Montana. Based at Western Montana College, Big Sky Telegraph customized conferencing software to create a powerful, easily teachable, on-line environment. Over the initial 10-month period, the system logged more than 10,000 calls resulting in 7,000 messages from some 450 callers, of whom approximately 150 are consistent users of the system. Frank Odasz, personal communication, December 1988.

Photo credit: Library of Congress

Wouldn't Miss Lamont have loved to have been linked electronically with other one-room schoolhouses?

- overcoming the feeling of isolation experienced by many teachers at various stages of their career.

Teachers often express the belief that they are alone and out of touch with their peers. With distance learning systems, communication among teachers on a consistent and structured basis can lead to solutions to common problems and concerns.[62]

Courses for Credit for Professional Development

Teachers, like other professionals, often have a desire to upgrade their skills in their field, either in pedagogy or in subject matter. But for many there is no university program nearby, limiting their options. Distance learning technologies can bring courses from universities or community colleges to them at home[63] or at nearby sites, perhaps in the local school. Even when universities are near, there can be advantages in providing professional development courses via distance learning technologies. For example, George Washington University in Washington, DC, has established, in cooperation with the District of Columbia schools and several school districts in nearby Maryland and Virginia, a master's degree in education and human development broadcast over their instructional television fixed service (ITFS) system. The districts negotiated a reduced tuition rate for their teachers, and provide space at local schools where teachers gather after school in small groups to take the courses.[64]

The phrase "televersity"[65] has been applied to programs like the National Technological University, one of the oldest and most successful nontraditional university programs, which serves the advanced educational needs of engineers, scientists, and technical managers. (See box 4-D.)

Box 4-D—National Technological University

The National Technological University (NTU) is a private, nonprofit institution founded to serve the advanced educational needs of today's busy, highly mobile engineers, scientists, and technical managers. NTU, which is governed by a Board of Trustees predominantly made up of industrial executives, began regular satellite delivery of advanced technical education in August 1985. Today NTU offers a wide range of instructional television courses taught by the top faculty of 28 of the Nation's leading engineering universities. Over 7,000 hours of academic credit instruction were provided to scientists and engineers choosing from the 455 courses offered by the participating universities in curriculums leading to Master's of Science in computer engineering, computer science, electrical engineering, engineering management, and manufacturing systems engineering. Two additional programs in materials science and management of technology were added in 1989. In addition, over 40,000 technical professionals participated in over 1,000 hours of noncredit state-of-the-art advanced technology and management programs.

Receiving sites are generally the laboratories and offices of the 60 some participating corporations and government agencies. Direct telephone lines from the receiving sites to the campus classroom provide for faculty-student interaction. The live classroom activity is supplemented by electronic mail, computer teleconferencing, and telephone office hours.[1]

Employee participation in courses is usually on work time and paid for by the subscribing corporation. Along with the quality of the educational courses, these factors are credited with much of NTU's success. Student motivation is high because of the support of their employers. The employer, in turn, benefits by being able to keep key staff up-to-date with technical information without losing them for long periods of study.

[1] National Technological University, *NTU: Executive Summary* (Fort Collins, CO: 1989).

Could such a comprehensive system of advanced professional education be developed and offered nationwide for teachers? Momentum toward this end is growing. In 1989, the Carnegie Foundation awarded a grant to New York University, on behalf of a group of institutions of higher learning, to study the prospect of a national distance learning consortium for teacher training.[66] One such effort is under way. Starting in the fall of 1989, the Joint Center for Telecommunications Studies, a collaboration between Howard University in Washington, DC, and the New York Institute of Technology, with support from Northern Telecom, will offer courses leading to master's and doctoral programs in education to teachers nationwide via telecommunications.[67]

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[62] New York State Legislative Commission on Science and Technology, op. cit., footnote 23, pp. 19-22.

[63] For example, Mind Extension University utilizes a cable channel to bring satellite courses from colleges and universities into the home. Both credit and noncredit courses are available. The 1989 summer schedule offered six education courses for credit from Colorado State University, one from the University of Minnesota and one from the University of Wisconsin at Stevens Point. Several other courses of interest to educators are offered from among the nine universities affiliated with the program.

[64] Janelle Leonard, District of Columbia Public Schools, personal communication, August 1989.

[65] Thomas L. Martin, Jr., *The Televersity: The University of the Future* (Surrey, England: Industry and Higher Education, September 1987).

The distance learning technology infrastructure in schools around the country may make it possible for teachers to participate in workplace professional development, but there are still a number of obstacles that must be surmounted. The success of these efforts will require cooperation between providers and the schools to guarantee that courses are relevant to the classroom needs. Universities and other program providers will have to collaborate with one another in involving the best teacher educators and subject area specialists. Administrative and fiscal support for teachers will also be required. Will schools follow industry's model and pay for tuition, provide release time, and cover transportation costs to a nearby site, or offer courses at school?

POLICY ISSUES

Technologies for learning at a distance, while reaching a small but growing number of teachers today, will clearly affect the teaching force of tomorrow. Some will teach through these systems, others will use them to add resources to their classrooms, and many will receive professional education and training over them. Few will be unaffected. These possibilities offer exciting opportunities for the profession. In the past, student enrollment changes meant that teachers were shifted to other schools, had to teach out-of-field, or left their home district altogether. Today teachers can continue teaching the subjects they love by combining students in electronic classrooms. As efforts expand, outstanding teachers can reach larger numbers of students than just those lucky few who happen to be in their home classrooms. They can become electronic mentors to other teachers in distant locations. Role models—superstar teachers, women in politics, minority scientists, poets, artists, business innovators, and creative individuals anywhere in the world—can join communities of learners and directly contribute to the instructional process.

But far more troubling visions could also occur. Will schools districts facing reduced funding use distance learning technologies as an excuse to cut back on needed staff? Limited resources might also place severe constraints on the flexibility and expandability of systems. Schools may find increasing competition for time on networks they helped create. Even more troubling would be investments in hardware and startup operations without adequate investment in the training and resources for teachers who will use the systems.

As policymakers invest in distance learning, they must consider systems to meet immediate needs, but also ensure long-term viability. Policy options serving immediate needs as well as long-term goals could include:

- support to schools and colleges of education enabling them to utilize distance learning technologies as tools to improve the preparation of new teachers;
- support for the development of local, State, regional, and national networks for teachers, for their ongoing professional development and informal communication;
- research on alternative teaching styles facilitated by distance learning technologies, with demonstration models and evaluation of ongoing efforts and long-term impacts;
- support for involvement with the private sector, through tax benefits, employee educational credits, or other means, encouraging their sharing in the provision of educational resources via distance learning technologies; and
- expansion of the infrastructure for distance learning technologies, so that more, and eventually all students, teachers, and districts can access the resources they need.

Setting long-term goals requires expanded vision. Restructuring education to meet the needs of the 21st century will involve today's technologies and tomorrow's. These technologies will not be ends in themselves, but means to an end—levers for change.

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[66] Arthur Melmed, New York University, Center for Educational Technology and Economic Productivity, personal communication, July 1989.

[67] Stan Silverman, New York Institute of Technology, personal communication, August 1989.

Distance learning has already been used to overcome problems that conventional instruction cannot address: problems of scale (not enough students in a single location) and scarcity (an instructional specialty not available locally). Distance learning also offers opportunities for the new kinds of learning that will be needed in a global information society. Restructuring efforts could include different arrangements of classrooms and schools. By overcoming pupils' segregation into isolated enclaves, distance learning makes possible different combinations of learner communities and teaching arrangements. Each school can be an "electronic magnet school," drawing in resources from the wider community. Students' learning environments will expand from the isolation of the classroom to the world; from individual insight to collaborative experience.[68] Similarly, doors will open for teachers.

> For those of us who have worked in schools that keep teachers distant from one another and condemn us to the chill of isolation, the idea that a teacher in Arizona can seek the counsel of a teacher in Florida is nothing short of exhilarating.[69]

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[68] Dede, op. cit., footnote 40, p.19.

[69] Mary Futrell, "The Last Frontier," *NEA Today*, December 1988, p. 2.

Chapter 5

State: Catalysts for Change

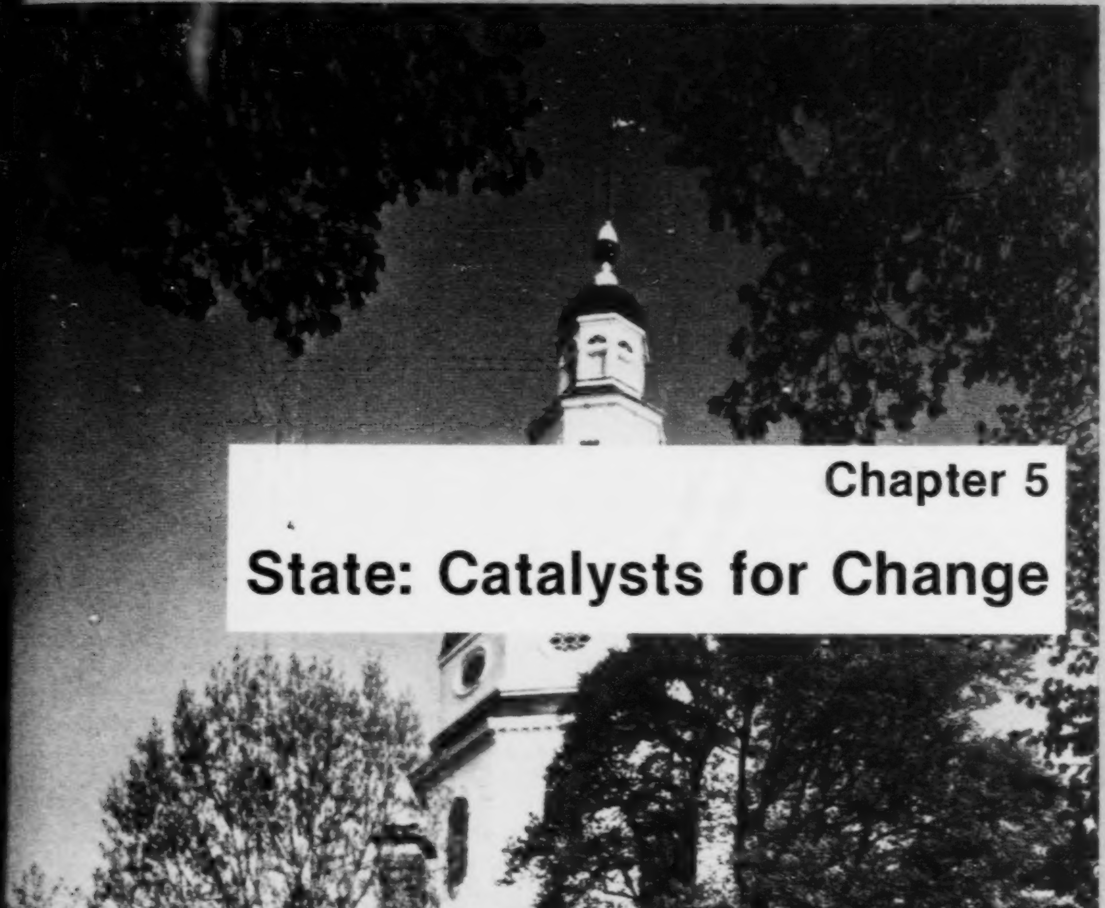

Photo credit: State of Maryland

State House, Maryland

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Chapter 5

States: Catalysts for Change

INTRODUCTION

States have become major players in planning, supporting, and organizing distance learning activities. This reflects the general increase in State activity in education as well as other public services, such as health, transportation, social welfare, and telecommunications. Expanded State authority over the last decade reflects both the reduced Federal role in these areas and the growing sophistication of State governments.

There are three underlying reasons why States are increasingly shaping and regulating distance learning. First, since responsibility for public education rests principally at the State level, it is only natural for States to shape distance learning policies. Second, as deregulation of telecommunications has occurred at the Federal level, many policy and regulatory issues in telecommunications have shifted to the States.[1] Finally, as critical decisions made at the local level affect future telecommunications services and facilities, some States have recognized that a statewide focus could improve the coordination and efficiency with which resources meet educational needs.

FINDINGS

- **State-mandated curriculum changes and increased requirements for graduation are driving distance learning developments.** A similar push has come from new course and distribution requirements for admission to State university systems. Increased standards have forced schools to find ways to offer a more extensive and intensive curriculum.
- Small and rural districts unable to meet the standards fixed by States have traditionally been forced to consolidate. Today technology provides an alternative. **The future of small and rural school districts may therefore be intimately tied to the availability of appropriate and affordable distance learning technologies.**
- Telecommunications systems initially targeted at isolated rural schools are now bringing needed resources into urban and suburban schools as well. Traditional classroom courses are being enhanced through the infusion of resources and new curriculum modules. Students at all learning levels and of varying skills can profit from the varied opportunities. States expect the systems to upgrade the teacher work force through inservice, professional development and networking. **As these new opportunities appear, competition for services will force States to carefully consider the equitable deployment of telecommunications resources.**
- State educational policies and telecommunications regulations are shaping the development of distance learning. **Yet present State policies may be outmoded and block the opportunities that advancing technologies offer for creating new classroom boundaries and new telecommunications services.**
- Educational policy conflicts center on traditional approaches to teacher certification, course credit, curriculum materials, and instructional logistics. **Little attention has been paid to how distance learning can meet broader school reform goals, such as restructuring education and using technologies as tools for change.**
- Many States look to telecommunications as a way to stimulate economic growth. **Where the education community has taken the lead in these planning efforts, it has had the unusual opportunity to be in the forefront of technological innovation and, through early involvement, to ensure that its needs are recognized and included in statewide telecommunications plans.**
- Although States have rarely worked together to solve common educational problems in the past, **distance learning provides economies of scale that encourage multistate use.** When new boundaries are created, educational and telecommunications issues will need to be resolved between the States.

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[1] See Lynne Gallagher and Dale Hatfield, *Distance Learning: Opportunities in Telecommunications Policy and Technology* (Washington, DC: The Annenberg Washington Program of Northwestern University, May 1989).

Photo credit: OTA staff

Many States have increased course requirements for high school graduation.

- Most State plans involve creative partnerships with the private sector that offer opportunities to provide resources for education. **As school districts band together as consumers for distance learning services, they become an attractive market for telecommunications providers.** This is a unique opportunity for schools, and one that should be pursued actively.

EDUCATIONAL REFORM: SETTING THE SCENE FOR DISTANCE LEARNING

The growing State interest in and support for distance learning parallels increased State involvement in educational reform. States have been driven by issues of equity, by economics, and by the pullback of Federal responsibility. States are taking many steps to meet school improvement goals. As noted by the National Governors' Association (NGA):

> States increased their financial support for public elementary and secondary education by $27 billion or 56 percent between 1980 and 1986. They set graduation standards for students and created major aid programs to help students meet those standards. They recruited more qualified teachers through higher salaries, better training, and demanding entry standards. They monitor the performance of school districts, and require corrective action when it is needed.[2]

Concern for the quality of public education follows the growing competition among States to maintain their existing industrial base as well as attract new development and industry. School quality is a key factor in attracting business. Companies require an educated work force as well as good schools for the children of their employees. Recognizing that good schools are essential to their State's economic vitality, legislators have focused on how students statewide measure against students nationwide, and how student achievement varies across districts. One response has been to set higher goals for all students, by raising requirements for high school graduation[3] and for entry into State university systems. As a result, foreign language and higher level mathematics and science courses, once optional, now must be offered if schools are to provide equal educational opportunities for all students. Schools have to find ways to teach these courses or be shut down.

Many States are turning to distance learning as a resource for improvement. In their annual report on education reform, NGA notes: "By far the most prominent area of State involvement in 1987-88 was distance learning or telecommunications."[4] Fewer than 10 States reported any involvement in telecommunications in the NGA 1987 survey. In the 1989 survey, 37 States reported distance learning initiatives and expansions of efforts already begun.[5] See appendix A for examples of State planning.

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[2] National Governors' Association, *National Governors' Association Policy Positions 1988-89* (Washington, DC: 1989), p. 51.

[3] In 1983, the National Commission on Excellence in Education recommended that high school students take more courses in the "New Basics"—4 years of English, 3 years of mathematics, 3 years of science, 3 years of social studies, and $^1/_2$ year of computer science. In addition, 2 years of a foreign language was strongly recommended for college-bound students. Forty-two States responded by raising coursework standards for high school graduation. Margaret E. Goertz, *State Educational Standards in the 50 States: An Update* (Princeton, NJ: Educational Testing Service, March 1988), p. 5.

[4] National Governors' Association, *Results in Education: 1988* (Washington DC: 1988), p. 29.

STATE PLANNING FOR EDUCATIONAL TELECOMMUNICATIONS NETWORKS

Education and telecommunications have both been the focus of State policymaking in the past; what is new is the convergence of these two State issues. This convergence has important implications for both fields separately and for the emerging hybrid of educational telecommunications policy.

Traditionally, there has been no one administrative or planning body looking at State educational telecommunications as a whole. State Education Agencies (SEAs) assumed responsibility for planning and financing the educational infrastructure, for conducting needs assessments, and for setting statewide educational standards that affect local school districts. State telecommunications policy most commonly is derived from input from a combination of authorities. In this broader arena, distance learning planning may come under the auspices of other State agencies, not just the SEAs. Educational telecommunications policy may emanate from the State telecommunications agency, the public television organization, the university system, the State Department of Education, or a special task force set up by the Governor or legislature. Texas, Hawaii, and Oregon present a range of examples of State planning for distance learning. Each planning process was unique, yet the overall goals and recommendations are quite similar.

In Texas, the impetus for change came from a legislative mandate to the State Board of Education to meet the requirements of the 1987 *Long-Range Plan of the State Board of Education for Public School Education*. One of the reports presented to the legislature, with recommendations for funding, was the *Long-Range Plan for Technology, 1988-2000*. Distance learning is one of four priority areas, along with classroom instruction, instructional management, and communications, outlined for meeting the goals for educational reform. In this context, distance learning is viewed as a vehicle for improving education. The plan focuses on today's classrooms and the changes needed to prepare an educated work force for the 21st century. State action is called for in meeting K-12 goals related to curriculum, attracting and retaining qualified and effective teachers, and improving instruction through innovation. The plan recommends that the State:

- . . . investigate, provide assistance for, and encourage implementation of distance learning technologies in order to provide a well-balanced curriculum to all students;
- . . . investigate, provide assistance for, and encourage implementation of distance learning technologies to overcome the absence of qualified teachers in sparsely populated areas;
- . . . coordinate public and private telecommunications systems for delivery of distance instruction and administrative services.[6]

In Hawaii, the State legislature appropriated $590,104 over 2 years (fiscal years 1987-88 and 1988-89) for the development of a Distance Learning Technology Plan.[7] The plan was prepared through a unique cooperative endeavor involving the Department of Labor and Industrial Relations, the Department of Education, and the University of Hawaii. These agencies worked together because of their common concerns for education in serving statewide employment priorities that ". . . will move Hawaii into a preferred future of the 21st century."[8]

> Successful education and training programs are not single-agency endeavors—they necessarily involve educational institutions with community partners, including business and government sectors. Cooperative problem identification, planning and implementation have produced training programs which optimize the use of limited resources, offer both short- and long-term solutions, and promote continued sharing of resources.[9]

In 1987, the Oregon legislature established an Ed-Net Committee, with nine members appointed by the Governor, to examine the prospect of a statewide telecommunications system. The ED-Net concept was initiated in 1985 when the American Electronics Association created a planning committee involving representatives from education, business, and Oregon Public Broadcasting. Ed-Net was originally envisioned as a television system that would make college and university courses available in all parts of the State, but the concept created under the plan[10] has a much broader focus, scope, and range of technologies:

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[5] Ibid., p. 31; and National Governors' Association, *Results in Education: 1989* (Washington, DC: 1989), p. 31.

[6] Texas State Board of Education, *1988-2000 Long-Range Plan for Technology* (Austin, TX: December 1988), p. 17.

[7] Hawaii State Department of Labor and Industrial Relations, *Distance Learning—Technology Plan* (Honolulu, HI: August 1988).

[8] Ibid., p. i.

[9] Ibid.

> Ed-Net can be a powerful tool for economic development, and simultaneously it will be a cost-effective way to broaden access to higher education, improve the delivery of instructional materials to schools, strengthen library services, and make governmental agencies and social service organizations better able to conduct their important training, education and information functions.[11]

Whatever the motivating force, the resulting State agency or newly formed organization is empowered to assemble and coordinate the various telecommunications users within a State to plan for ways to meet common goals and needs.[12] This coordination can be "horizontal," when accommodating a range of State agencies that share telecommunications needs despite varying responsibilities and audiences (e.g., Departments of Corrections, Health and Human Services, Public Works and Transportation, Labor, and Education). Coordination can also be "vertical" between levels of a particular agency. **Of special interest in the education sector are linkages among the providers of educational services across the elementary, secondary, university, and continuing education spectrum. A common sense of purpose fostered by planning for shared telecommunications needs can lead to new constructive dialogs and relationships among agencies responsible for education, creating a bond that unifies these typically independent communities.**

In several States, the educational institutions have been in the forefront in statewide telecommunications planning. Iowa and Maine provide two examples. Both States were looking for ways to provide educational services equitably to their constituents dispersed across great distances. Iowa had a system of community colleges and some experience in reaching out to learners via telecommunications. Planning centered on meeting educational needs, coordinating resources, and avoiding costly duplication of services. The Iowa network will assure that all parts of the State receive equal attention. (See figure 5-1 and chapter 1, box 1-D.) Maine was in a different position, using distance learning technologies to provide a community college system for the State. (See box 5-A.) Connecticut provides a third example. (See box 5-B.)

THE STATE EDUCATION AGENCY

State Education Agencies can play a major role in distance learning because of their responsibility to assure that all school age children in the State are provided equal educational opportunities, regardless of school size or location. An SEA typically determines State funding distribution, sets statewide curriculum standards and graduation requirements, regulates teacher certification and recertification policies, and provides technical assistance to local districts. State leadership can be a strong force in articulating educational goals and illustrating how solutions like the use of distance learning technologies can help address them.

There are, however, likely to be circumstances where the State view and the local view will diverge, especially in the area of providing service to small rural schools.[13] Since State education authorities are generally charged by law with oversight of the educational enterprise, they must consider basic questions of adequacy, efficiency, and equity of the entire State system. The local community may have a strong bias toward preserving the small, often isolated rural school at all costs, as a key to the continuing life of the community. When local

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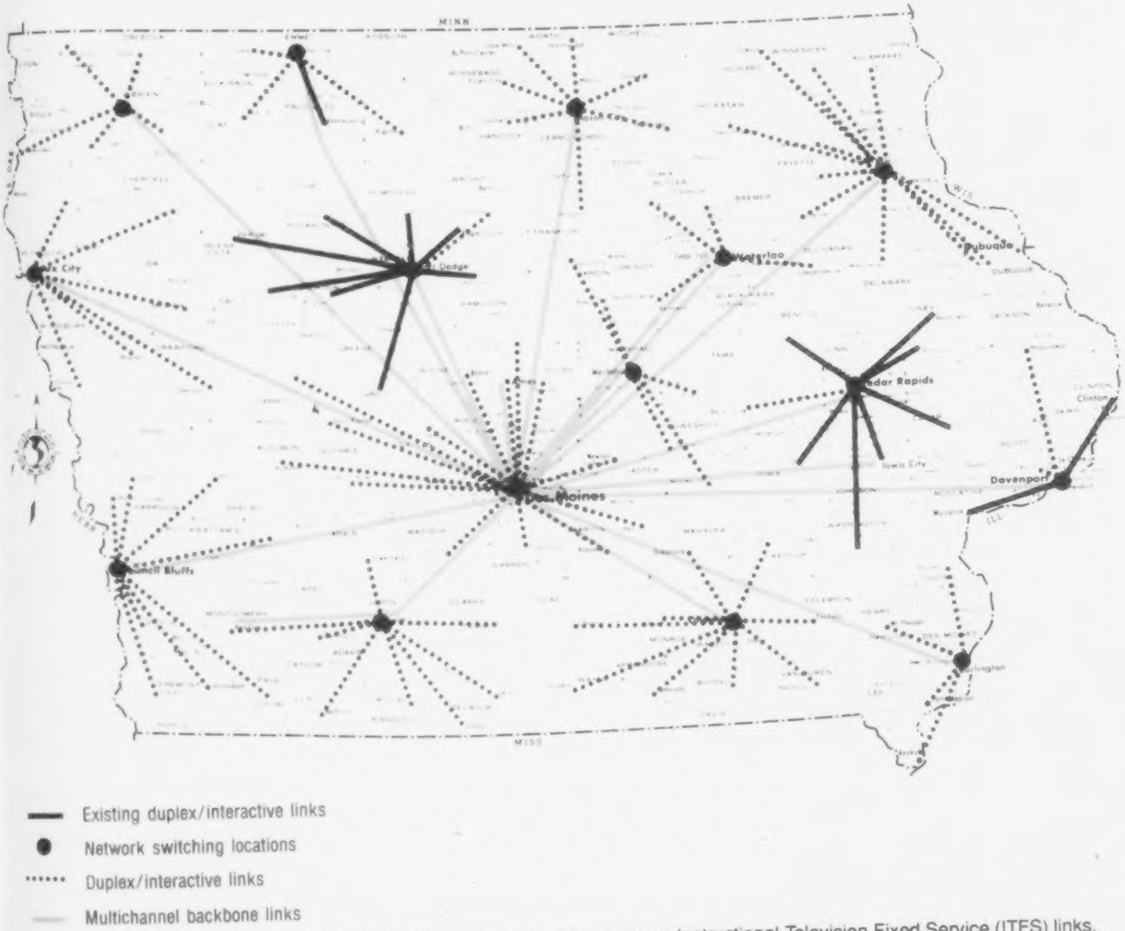
[10] Oregon Ed-Net Committee, *Oregon Ed-Net: A Report on the Feasibility of a Statewide Telecommunications Network* (Salem, OR: July 1988).

[11] Ibid., p. 1-1.

[12] In Washington State, planning efforts by the Office of Public Instruction, the Higher Education Coordinating Board, and the Department of Community Development came together when the three groups found areas of common ground. The resulting proposal outlined a system where telecommunications resources and services could be shared at considerable savings to taxpayers. See Washington State Office of the Superintendent of Public Instruction et al., *Proposal for Sharing Video Telecommunications Resources* (Olympia, WA: January 1989).

[13] Kenneth H. Hansen, *Distance Education and the Small School: Policy Issues* (Portland, OR: Northwest Center for State Educational Policy Studies, Northwest Regional Educational Laboratory, August 1987), p. 3.

Figure 5-1—Iowa Educational Telecommunications Network


MINN
Dubuque
Waterloo
Cedar Rapids
Clinton
Iowa City
Davenport
Des Moines
Council Bluffs
MISS
ILL
WIS
▬ Existing duplex/interactive links
● Network switching locations
•••••• Duplex/interactive links
— Multichannel backbone links

Communities all across Iowa will be connected to the network through numerous Instructional Television Fixed Service (ITFS) links.

SOURCE: Iowa Public Television.

interests and State interests conflict, new solutions such as distance learning technologies may provide a partial solution. (See box 5-C.)

Organization and Management of Distance Learning in State Education Agencies

Management of distance learning within SEAs varies.[14] Distance education, in contrast to computer education, has yet to find its niche in SEAs. Over the last few years almost all the States have created an educational technology division or director within their SEA.[15] In most cases, these technology directors or offices have been responsible for developing policies and support for procedures for computer hardware and software purchases, software evaluation, technical assistance, curriculum development, and teacher training in computer use. They are not necessarily charged with planning or administering distance learning efforts in their States.

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[14] Much of this discussion comes from Donald C. Holznagel and Thomas Olson, Northwest Regional Educational Laboratory, "A Study of Distance Education Policies in State Education Agencies," OTA contractor report, February 1989.

[15] In the 1988 OTA survey of the States, 41 States had a technology division or staff position for educational technology, 24 had a long-range plan for educational technology, and 13 others had plans under development. U.S. Congress, Office of Technology Assessment, *Power On! New Tools for Teaching and Learning*, OTA-SET-379 (Washington, DC: U.S. Government Printing Office, September 1988).

Box 5-A—Maine's Telecommunications Network: A Community College for the State[1]

Planning for a statewide telecommunications system in Maine was driven by a clear need to improve overall educational opportunities in the State. The statistics are stark: approximately one-quarter of Maine adults are functionally illiterate, 37.5 percent have not earned a G.E.D. or high school diploma, and real earned income of workers places them 49th in the Nation. The State ranks last in adults participating in higher education and 48th in high school students seeking postsecondary education.

These statistics reflect a collection of problems that currently serve as barriers to education. Perhaps the greatest barrier is Maine's size (the State is as large as the other five New England States combined) and dispersed population, a combination that has made access to educational services difficult. Today two-thirds of the population live beyond a reasonable commuting distance of one of the State's seven university campuses or one of the six postsecondary vocational-technical institutes. Severe weather, predominantly secondary roads, and limited public transportation systems compound the problems of geographic isolation. In addition to these geographic obstacles, a shortage of faculty at both the high school and postsecondary level, combined with increasing costs of instruction, create additional educational problems, especially in the State's rural areas. At the same time, the State found itself facing demands to increase the breadth and depth of curriculum available to all students at the high school and postsecondary level.

The University of Maine system has been a key player in seeking solutions to these statewide educational challenges. Recognizing the declining number of students who typically make up the pool from which university students are drawn—the 18 to 22 year-old just leaving high school—the university looked for a way to reach a broader spectrum of learners. University leaders were convinced that the State had to find a way for older, part-time, and commuter students to access educational programs. Nationally, approximately 40 percent of all students enrolled in higher education are served in community colleges, but Maine had no community college system.

As a result of a 2-year planning process, involving the faculty and staff of each of the seven campuses in the university system, the six vocational-technical institutes, and the public schools, a Plan for a Community College of Maine/Telecommunications System was adopted. This plan calls for the development of a telecommunications delivery system allowing the transmission of "live" classes by linking existing campuses of the university, the vocational-technical institutes, the Maine Maritime Academy, numerous off-campus centers, and all the public high schools in the State. The plan also calls for 50 locations to be on-line by September 1989, the first year of operation of the statewide system. In effect, telecommunications will create the community college system for the State.

The technical specifications call for a fiber optic spine (a high-speed electronic highway) linking the campuses, each of which will be transmission sites. Several of the off-campus centers will also have transmission capability when the system is complete. The fiber optic spine will carry three channels of full duplex (two-way) video, audio, and data, while an Instructional Television Fixed Service microwave system will extend beyond the spine and carry two channels of video, audio, and data, with audio return. The University of Maine at Augusta (UMA) will serve as both the hub of the terrestrial system and the site for satellite linkages. Dishes on all high schools, State and local government buildings, hospitals, and businesses, and cable television systems will make live programming available to users across the State. Course materials, examinations, syllabi, and data can be distributed electronically (using facsimile machines and computers) or by mail between sites. Funding for the system has come from Federal Higher Education Act Title III grants and from a $2.2 million appropriation from the State legislature.

In the first year of operation, programming will include a statewide offering of UMA's Associate Degree in General Studies. Twenty-six courses will be broadcast each semester of the 1989-90 school year. Five additional graduate-level courses will be broadcast by the university. Nine courses and workshops will be offered over the instructional television system by the vocational-technical institutes, and high schools and the Department of Educational and Cultural Services have been allocated 5 hours per day on the system. Inservice training for teachers is expected to be a major use for the system. In all, the system will broadcast live courses over two channels from 7 a.m. to 10 p.m. Monday through Friday, and from 8 a.m. to 4 p.m. on Saturday.

Maine illustrates how a State can, with coordinated planning, use a telecommunications system as a means to address a range of problems.

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[1] Much of this discussion comes from George P. Connick and Pamela MacBrayne, University of Maine-Augusta, "Educational Access and Telecommunications in Maine," unpublished manuscript, April 1988.

Box 5-B—Piecing Together Educational Telecommunications: The Connecticut Approach[1]

Although Connecticut has not adopted a formal State plan for educational telecommunications, it has developed a multifaceted approach to providing education over a distance. The components of the system are designed to operate independently, but, since they serve convergent needs, they may interconnect when completed. The backbone of the system is StateNet, a fiber optic and copper cable network. This system will serve all State government agencies, predominantly for data and voice transmission. Immediate plans do not call for educational use; however, once the telecommunications needs of government and education are more clearly defined, StateNet may carry education traffic.

The second facet is an Instructional Television Fixed Service (ITFS) network that will allow schools and businesses all over the State to access courses and enrichment materials from many providers, including the State's community colleges, which already have their own small ITFS network. The State Department of Education is charged with building and operating the K-12 ITFS system. The system will provide instructional television, distance delivery of courses, professional development, teleconferences, and materials distribution among schools. The first phase of this system, serving 25 school districts, became operational September 1989. The complete system serving all school districts is projected for 1991.

A Telecommunications Incentive Grant Program, authorized by the Connecticut General Assembly in 1986, provides funding to local districts and regional education agencies for planning, operating, and expanding the use of telecommunications in education. Most of these grants are small (none has exceeded $23,000), in keeping with State goals to promote a variety of approaches and to encourage the commitment of local districts. Grants awarded so far total $252,000, approximately $85,000 per year. As a result of interest generated by the Telecommunications Incentive Grant Program, the State Department of Education is also cooperating with Southern New England Telephone (SNET) to explore how schools could better apply telecommunications services to education. SNET funded the pilot program, at a cost of approximately $1.5 million. Three types of "links" operate at different sites throughout the State. The "voice link" uses a voice message system to promote links between parents and teachers. The "data link" gives students and teachers access to remote databases through personal computers in the school library. The "video link" connects sites with an interactive two-way video system. One of these video links connects an Advanced Placement Spanish language high school class in suburban West Hartford with an advanced class of native Spanish speakers in Hartford's inner city. A future video link will provide engineering classes, taught by professors from the University of Connecticut, to high schools via the system. The College of Education at the University of Hartford also has indicated interest in joining the project to expand classroom observation and student teaching experiences. SNET plans to continue funding for an additional year in order to evaluate how the technology is being used in the pilot projects, and the State will fund 10 additional data link sites.

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[1] OTA site visit, February 1989.

Even in those States where the State education department has developed a plan for distance learning, there may be the mistaken assumption that distance education technologies can be treated in the same manner as computer technology in the planning process, ignoring the unique impacts of distance education on areas such as teacher certification, curriculum approval, and funding formulas. And, while most States involved in planning are taking an active role, the tone, format, and level of involvement varies. Some States see their role as a "bully pulpit" to encourage local activity, while others provide direct support for local demonstration projects. Some States only go so far as to disseminate information and technical assistance, while others are more assertive in the setting of standards and development of materials.

In the OTA analysis of State policies,[16] 21 States were studied for their policies regarding distance learning. Legislative mandates, policy documents, technology plans, distance education plans, and telecommunications plans were reviewed as possible sources for State policies on distance education. Only 7 of the 21 States sampled have policy documents specific to distance learning. Another survey, taken by the Council of Chief State School Officers in February 1989,[17] had similar findings. Judging from the sample of States surveyed, most

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[16] Holznagel and Olson, op. cit., footnote 14.

[17] Council of Chief State School Officers, "State Survey on Distance Education Networks," unpublished document, February 1989.

Box 5-C—Benefits of Preserving Small Schools

Education is an intimate process.[1]

One benefit of distance learning technology is its potential for allowing small, underserved schools and school districts to remain active despite waning student populations and a shortage of critical resources. According to the U.S. Department of Education, approximately 75 percent of the 15,579 school districts in the United States can be classified as small (less than 2,500 students).[2] These districts enroll slightly over 20 percent of the Nation's student population. Additionally, over one-half of the school districts in the United States can be classified as both small and rural.[3] These districts are often geographically isolated, and suffer from a lack of funds, a shortage of qualified teachers, a minimum of resources, and limited course offerings—especially advanced courses. In Texas, for example, small school districts offer, in general, only about one-third the number of courses offered by larger districts, while rural districts offer only about one-quarter as many courses as do their major urban counterparts.[4] Through distance learning, however, small and rural districts can provide some of these previously unavailable courses, giving their students educational opportunities similar to those offered students in larger urban and suburban districts.

For many years, the most viable option available to school administrators faced with the limited curricular offerings in small schools was to consolidate schools and school districts. Some education experts, however, have begun to challenge the belief that "bigger is better." For example, recent studies have demonstrated that small schools and school districts often promote high levels of student achievement. A study of New Jersey school districts concluded that in " . . . all cases, larger district enrollments are associated with lower test scores."[5] Even when the socioeconomic status and expenditure levels of each district were taken into account, the conclusion was the same: the larger districts in the study were generally less efficient in attaining achievement. Other studies of individual schools have resulted in similar conclusions. A 1975 survey of Colorado schools determined that " . . . large school size lowered achievement levels."[6]

Research also shows that smaller school districts are generally as cost efficient as their larger counterparts. The New Jersey study found that although very small districts (those with fewer than 300 students) spend more per student than larger districts, the " . . . per student costs of districts with 500 to 5,000 students and over . . . differ

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[1] Jane Russo, "College Comes to North Haven," *Community College of Maine Newsletter*, prepared by the University of Maine, Augusta, Office of Distance Education, vol. 1, No. 3, August 1989, p. 1.

[2] U.S. Department of Education, National Center for Education Statistics, "Public Elementary/Seccodary Education Agency Universe Survey, 1987-88," unpublished document, 1989.

[3] Bob Cole, "Teaching in a Time Machine: The 'Make-Do' Mentality in Small-Town Schools," *Phi Delta Kappan*, October 1988, pp. 139-144.

[4] In Texas school districts with 50,000 or more students, the average number of courses offered in 1985-86 and 1986-87 was 209; in districts with 1,000 to 1,599 students, the average number of courses offered was 76. For those school districts with fewer than 500 students, this figure was 54 courses. When analyzing district type, major urban districts in Texas offered on average 200 courses, while rural district offerings averaged 56. Texas Education Agency, *1988-2000 Long-Range Plan for Technology* (Austin, TX: December 1988), p. 26

[5] Herbert J. Walberg and William J. Fowler, Jr., *Expenditure and Size Efficiencies of Public School Districts* (Chicago, IL: Heartland Institute, September 1988), p. 17.

[6] Kenneth F. Palmer, "Small Is Beautiful: Schools As If Kids Mattered," *The Clearing House*, vol. 51, No. 9, May 1978, p. 437.

States have yet to spell out specific policies that guide distance learning. In most cases existing State policies become, de facto, the basis for distance learning policy in the State. This is particularly true in States where distance learning projects are locally based and do not involve importing courses from out-of-State. Where multistate courses are brought in by satellite, however, some States have felt more pressure to develop policies addressing issues such as what is required of teachers and what curriculum and texts can be used.

In both the telecommunications and the educational arenas there is a tension between the State's role as regulator and as empowerer. In the education policy arena, States have traditionally served as regulators to assure that quality standards are met in all schools across the State and that all children are equally well served by the public education system. Consequently, educational policies tend to be restrictive, focusing on minimum standards of traditional instruction. While important, these policies tend to maintain the status quo.

very little."[7] Additionally, since the New Jersey study had previously determined that smaller districts generally produce higher standardized test results, it has been suggested that smaller districts actually attain "... more achievement value per dollar..." than do larger districts.[8]

Student participation—both in the classroom and in extracurricular activities—was also found to be higher in smaller schools. Small class size, close teacher-pupil relationships, and more personal attention all result in higher levels of student participation in the classroom. Students at smaller schools typically participate in more extracurricular activities as well. Although larger schools are able to provide a greater number of activities, research has shown that "... students from small schools participated in a wider variety of extracurricular activities than did students from large schools, and a much larger portion of students from small schools held important and responsible positions ... than did students from large schools."[9]

Clearly, the challenges faced by teachers in small, rural schools are substantial. Often, they must contend with a lack of resources, little technical assistance, geographic isolation, and low pay. Nonetheless, small schools can offer numerous advantages to their staff that large schools cannot. For instance, teachers clearly prefer smaller classes and increased personal contact with students that small schools offer. Less tangible advantages, such as a heightened sense of efficacy, existence of a functional support system, and a stronger identification with the school, are more prevalent in smaller schools as well.[10] These factors all contribute positively to the way in which teachers identify with their school. Finally, smaller schools have generally demonstrated a more desirable social climate than larger ones. Due to their isolation, as well as the small population served, many smaller schools create a heightened sense of community as well as "... the special feeling that each student matters."[11] As a result, smaller schools do not experience as many behavior problems. Studies have shown that the "... relative incidence of student truancies, teacher assaults, vandalism, intra-student fighting, school expulsions and dropouts ... increase as student population density increases."[12] Additionally, attendance and student satisfaction levels are generally higher at smaller schools.[13] It appears, then, that the "community" environment of small schools creates a nurturing atmosphere for both teachers and students.

Small, rural schools face special problems that affect their ability to remain competitive in the educational marketplace. However, the numerous positive attributes of smallness argue for their preservation. In order to compete effectively, small schools must be provided with the same resources and advantages as their larger counterparts. Distance learning can provide at least a partial solution to this dilemma, by helping to keep small schools and school districts open in the face of consolidation.

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[7] Walberg and Fowler, op. cit., footnote 5, p. 6.

[8] Ibid., p. 17.

[9] Roger G. Barker and Paul V. Gump, *Big School, Small School: High School Size and Student Behavior* (Palo Alto, CA: Stanford University Press, 1964), cited in Gary Green and Wanda Stevens, "What Research Says About Small Schools," *Rural Educator*, vol. 10, fall 1988, p. 10.

[10] Cole, op. cit., footnote 3, p. 144.

[11] Ibid.

[12] Edward J. Kelly, "Our Overcrowded Schools: Current Problems and Future Prospects," *College Student Journal Monograph*, vol. 10, No. 2, Part 2, spring 1976, p. 3.

[13] Paul Lindsay, "The Effect of High School Size on Student Participation, Satisfaction and Attendance," *Educational Evaluation and Policy Analysis I*, spring 1982, p. 60.

Far less common are empowering policies, which encourage experimentation to try to meet needs in new and innovative ways, even if it means relaxing, bending, or eliminating previous restrictions.

A comparable tension is seen in telecommunications policy. State public utility commissions are charged with protecting consumers today and keeping rates as low and as fair as possible. However, the regulations that respond to this goal may make it difficult for telephone companies under their jurisdiction to modernize in order to provide broader or more innovative service in the future. This philosophical battle has broad consequences for the future economic development in a State. Do policies mortgage today's consumer to pay for better services in the future? Another issue is equity v. public service: is it appropriate for one class of user to subsidize service to others if a public interest will be served by this subsidy?

The tension between empowerment and regulation also is evident in the marriage of education policy and telecommunications policy. Should telecommunications policy support innovation for the educational needs of a State as a way of ultimately best serving the interest of the citizens and businesses of that State? Should educational needs drive the telecommunications policy? How can States balance the need for innovation with the need to contain rising costs for services?

OTA finds that States are today in a position to rewrite or develop new educational policies in light of the special opportunities and challenges posed by distance learning options. The broad question for educational telecommunications policymakers is how to enable practitioners to take advantage of the opportunities presented, yet meet standards for educational quality. Binding districts with restrictive regulations shaped by an older model of education is inappropriate for the new educational models distance learning can make possible. **By superimposing yesterday's rules on tomorrow's opportunities, States may be cutting off options before they can be fully developed and tried.** A regulatory moratorium may be needed to allow for experimentation and evaluation of distance learning's role in meeting critical educational needs.

STATE EDUCATION POLICIES AND DISTANCE LEARNING ISSUES

The sections below present illustrative policies addressing distance learning issues from State documents sampled in the OTA survey mentioned earlier.

General Philosophy

Most State distance learning policies are motivated by the mandate to provide all students equal access to education. Technology is often cited as a means to attain this goal. North Carolina, for example, has taken a comprehensive approach, using satellite downlinks as the vehicle for equalizing educational opportunities across the State. (See box 5-D.)

This directive from the North Carolina General Assembly is clear:

> (a) It is the continuing intent of the General Assembly that every child in the State's public school system shall have equal access to educational opportunities, no matter where the child lives or how small the school which the child attends. It is the further intent of the Assembly to encourage and subsidize state-of-the-art technology as an efficient and cost-effective means of making equal access to opportunity available to all children.
>
> (b) The State Board of Education shall establish one satellite earth station at the 54 smallest and most rural schools in the State, to insure that students in these schools have full access to all courses required in the Basic Education Program that small enrollment or lack of qualified teachers would otherwise make unavailable.[18]

Despite the general goal of providing educational equity, States are concerned that distance learning projects meet established standards for curriculum and instruction. This concern is reflected in a variety of policy statements regulating how and when distance learning technologies can and should be used. A central issue is that of certification and training requirements for the teacher delivering a course from the originating site (teleteacher), and for the teacher or classroom aide (facilitator) at the receiving site. Other issues are course credit, State approval for courses, and classroom and instructional logistics.

Certification of Teleteachers

The certification of the teleteacher is the most prominent issue that SEAs are grappling with regarding distance learning. This is particularly true when a complete course of instruction originates in one State and is received in another State. Most States require that any course offered for credit must be taught by a teacher who possesses a valid teaching certificate in that State. Because few States grant automatic reciprocity to teaching credentials from another State, teleteachers in multistate projects must apply for certification in each State where courses are received. In some cases, the teleteacher must not only meet individual course requirements in State history, counseling, and guidance, but also pass several competency examinations, in subject areas as well as State and national teacher examinations. Fingerprint checks and physical examinations may be required, despite the fact that the teleteacher may never physically step into the State. Finally, after meeting coursework, health, and competency requirements, teachers in multistate distance learning projects may also need to meet individual State and local requirements relative to student teaching experience, time spent in classroom

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[18] General Assembly of North Carolina, S. 298, "Learning by Satellite," sess. 1987, Apr. 6, 1987.

Box 5-D—North Carolina's Distance Learning by Satellite Program[1]

In January 1988, the North Carolina State Department of Public Instruction (SDPI) and the TI-IN Network of San Antonio, Texas, entered a contractual agreement to form a statewide satellite network to provide high school instruction and staff development throughout the State. This statewide investment and partnership with a private corporation was motivated by the realization that: "North Carolina has many small, rural high schools which, because of low enrollment and remote locations, cannot offer all the courses mandated by our state's Basic Education Plan. North Carolina has desperately needed an alternative method to bring students the kind of education envisioned by developers of the (basic education) plan."[2] Interest in making quality staff development and training more accessible to all educational employees around the State was another factor spurring the Department's interest.

As a first step, SDPI staff investigated several distance learning programs across the country, and surveyed principals of the State's smallest rural high schools to determine the areas of greatest curricular need. During the 1985-86 school year, the State piloted distance learning by satellite at four sites with Federal Title II grant monies. The pilot used TI-IN Network programming and hardware to provide staff development training on the use of computers in the classroom. Participating teachers were very positive. Information on the pilot, the survey data, and examples of services that could be offered to North Carolina were provided to legislators, and the 1987 General Assembly passed the Learning by Satellite bill.

The bill appropriated just under $2 million for fiscal year 1987-88 to purchase satellite receiver equipment and hardware for 153 sites. The sites were SPDI, each of the 52 smallest high schools in the State, and 100 additional sites chosen by district superintendents for staff development programming. The legislature allocated $1.04 million for fiscal year 1988-89 for satellite programming ($944,850) and staff support for the project ($95,150).

Under the North Carolina plan, a district coordinator oversees satellite programming for all receive sites within each participating district; at each site, one person serves as manager (usually the principal or assistant principal). Each school site also has a classroom facilitator and an equipment manager. For the 52 small, rural high schools, State funds cover the annual subscription fee ($4,750 per school in North Carolina, a rate lower than TI-IN's normal subscription fee), staff development programming fees (determined by the district's average daily attendance), and course fees for a maximum of 20 students at each school ($240 per student per course per semester, plus $50 extra for foreign language and science laboratory classes). If the number of enrolled students exceeds 20, the local school must pay tuition fees. In the first year, over 1,100 high school students enrolled in the satellite classes.

OTA visited with administrators, teachers, and students participating in the first-year effort in North Carolina's Region 8. The project got high grades for expanding curriculum offerings and for the quality of teleteachers, but there were concerns regarding student/teacher interaction. As one principal stated: "In a small school like ours, students are used to a great deal of individual attention. We had to adjust our attitude on this for satellite classes."[3] And, as in many distance learning projects, coordinating bell schedules, school calendars, and grading periods presented problems. Although each of the principals was pleased to have TI-IN classes in their schools, six of the seven indicated that, without State funding, the program would not continue. As another principal said: "This is something which the State has provided and I'll use it. But, this is not something that I would go out and purchase for our own school from local monies."[4]

North Carolina is a member of the TI-IN United Star Schools Network and has added 17 new sites to the statewide network as a result of Star Schools funding. Under special arrangements with TI-IN, North Carolina uses the network for staff development 1 hour per week. SDPI also developed their own 18-hour methods course for teaching foreign languages in the elementary grades, which is available on the network.

North Carolina's distance learning efforts are expected to expand to more schools and to offer a wider array of programming in the future. This support is grounded in the bill that authorized the program: "It is the intent of the General Assembly that the Distance Learning by Satellite program shall be an ongoing component of the public school system and that operational funds for the program shall be included in future continuation budgets."[5]

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[1] Much of this discussion comes from Bruce Barker, Texas Tech University, "Distance Learning Case Studies," OTA contractor report, June 1989.

[2] Elsie Brumback, assistant superintendent, North Carolina State Department of Public Instruction, in *TI-IN Network News*, 1988, p. 1.

[3] Barker, op. cit., footnote 1, p. 20.

[4] Ibid., p. 21.

[5] General Assembly of North Carolina, "Learning by Satellite," Senate Bill 298, Sess. 1987.

instruction, and possibly additional requirements of individual school districts.[19] When a distance learning course is taught by others, whether they be university professors, scientists, artists, poets, government officials, or any other subject matter experts, these restrictive requirements may make it impossible for the course to be accepted in a particular State.

At present, there are no generally applied standards for teleteachers. Some States (e.g., Utah, Nevada, and Alaska)[20] do not require certification for the teleteacher in either the State where the course originates or in the receiving State. Others (e.g., Idaho and Washington)[21] require certification in both the sending and the receiving State. These statements from Idaho, Minnesota, and Montana illustrate three different approaches.

> A teacher must hold a teaching certificate valid in the State where the program originates and must meet the minimum academic requirements of the Northwest Accrediting Association.[22]
>
> The satellite course teacher must have a Minnesota teaching license.[23]
>
> To use distance learning programs, local school districts shall apply for an alternative by validating that the teachers of distance learning courses are certified and appropriately endorsed in Montana or in their resident State and have experience in delivering instruction via distance learning.[24]

Many States have not yet established a policy regarding certification of teleteachers and the teleteachers are approved on a case-by-case basis.

Several of the producers of satellite courses for high school credit have worked out separate arrangements for certification of their teachers across State lines. In the Satellite Telecommunications Educational Programming (STEP) network, which originates in Washington State, all high school teachers hold current Washington State teaching certificates.[25] Reciprocity agreements for teacher certification have been arranged in the seven other States receiving STEP high school courses. However, this reciprocity varies among the receiving States.[26] Teachers in the TI-IN Network, a private corporation supplying a range of courses nationwide, must hold teaching certificates for each of the States in which their courses are received. In Oklahoma State University's Arts and Sciences Telecommunications System (ASTS), all teleteachers are university professors and generally do not hold K-12 teaching certification. However, ASTS requires that facilitators in the receiving classrooms must be certified teachers, although not necessarily endorsed in the distance learning course subject. ASTS staff work with SEAs and, to reassure reluctant State education personnel about the quality of the teaching over the system, send them tapes of their teleteachers teaching lessons. With their courses now being used in classrooms in 35 States, ASTS has been turned down by only 1 State.[27]

One lever for dealing with the issue of cross-state certification of teachers may be the professional standards being developed by the National Board for Professional Teaching Standards, formed in 1987 as a result of recommendations in *A Nation Prepared: Teachers for the 21st Century*.[28] The Board's goal is to improve education by raising the standards of the teaching profession by recognizing first-rate teachers, providing them with better compensation, and placing important decisions about teaching policy and practice in their hands. The certification process is one key step toward these goals.

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[19] Lloyd Otterman and Pamela Pease, "The Role of Private Business in Distance Learning: The Educational Partnership," OTA contractor report, June 1989, pp. 17-18.

[20] Northwest Association of Schools and Colleges, "Survey of Distance Learning," unpublished document, December 1988.

[21] Ibid. Both these States indicated they are studying the issue. In Washington, the standard is considered most important if the course is used to meet graduation requirements.

[22] Idaho Department of Education, "Idaho Guidelines Regarding Distance Learning," unpublished document, 1987.

[23] Gilbert M. Valdez, manager, Instructional Design Section and James E. Sauter, assistant commissioner, Division of Education Effectiveness, Minnesota Department of Education, "Satellite Course Requirements," memo outlining areas in State Board of Education rules pertinent to satellite courses, Mar. 31, 1988.

[24] Montana Board of Education, Rule 10.55.907, Distance Learning (d), effective July 1, 1989.

[25] See Bruce Barker, Texas Tech University, "Distance Learning Case Studies," OTA contractor report, June 1989.

[26] For example, one STEP high school teacher, certified to teach precalculus/calculus, was required to take a first aid course in order to teach in Oregon, even though the course is broadcast from Washington State and she may never enter the Oregon classrooms receiving her course. Debra Willson, STEP teacher, Spokane, WA, personal communication, June 16, 1989.

[27] Smith Holt, Oklahoma State University, personal communication, August 1989.

[28] Carnegie Forum on Education and the Economy, *A Nation Prepared: Teachers for the 21st Century*, The Report of the Task Force on Teaching as a Profession (Washington DC: May 1986).

At present, teachers are subject to State licensing systems that set minimum entry-level standards and vary considerably from State to State. The national certification, which would be voluntary, goes beyond this minimum proficiency level. Board certified teachers will have to meet high and rigorous standards of experience, creativity, professional judgment, and teaching skill, as determined by a range of assessment procedures including such techniques as simulations of classroom situations, observations of teachers in a school setting, interviews, essays, oral defenses of teaching portfolios, and written examinations. The concept of national certification will, in many respects, correspond to the standards applied in the certification systems used by other professionals in such fields as medicine, architecture, and accounting.

Because the Board expects to adopt a single set of standards and assessment practices to be applied uniformly across the country, it is anticipated that State reciprocity agreements will be facilitated, making it easier for teachers to teach in States other than those in which they were originally licensed. This is important in light of today's variable demand for teachers from State to State. It also has implications for the question of cross-state acceptance of teachers on distance learning systems. Since the national certification process goes above and beyond what would normally be required to teach in any one State, it would appear that a Board certified teleteacher would be acceptable to any State. There has as yet been no discussion of creating a separate certification around a subspecialty of distance learning or teleteachers, but the concept could evolve, especially if distance learning projects continue to blossom across the country. Finally, distance learning technologies themselves may be used as a part of the assessment procedure. Teachers could be observed in their everyday teaching activities and evaluated based on a set of these observations.

Requirements for Classroom Facilitators

There is great variation in State policies regarding the facilitator or monitor, the person responsible for the students at a receiving site. Policies range from the most open[29] to the most restrictive. In States like Washington, the on-site monitor must be certified in the subject being delivered if the course is used to fulfill graduation requirements.[30] It may be in cases such as this that the teacher has general certification, for example, high school mathematics, but is not trained to teach a higher level course such as calculus or an Advanced Placement course. In such instances, the classroom monitor can be learning how to teach the course and may indeed take over teaching that subject in subsequent years. Several States (e.g., Alaska and Oregon) require a teacher as a monitor, but do not require that they be certified in the subject. Most common is the model in which noncertified personnel (aides) serve as monitors, usually after special training. In some cases, these aides must be supervised by certified staff.

Training and Staff Development

Several States have established policies that mandate inservice or preservice instruction for any aides or teachers involved in distance learning activities. For example:

> The satellite classroom instructor shall receive inservice training pertaining to the course organization, classroom management, and technical aspects.[31]
>
> The teacher will participate in instructional and technical inservice education developed and made available by the developer or sponsor of the approved course.[32]

These States recognize that successful implementation of distance learning activities require that the teleteacher be trained in the most effective use of the medium, and that the on-site monitor be trained in classroom management. One State with considerable experience in distance learning produced a guide

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[29] For example, in many of Minnesota's district-run projects using two-way video interactivity there may be no adult at all in the receiving classroom. See Minnesota Department of Education, Instructional Design Section, *Interactive Television Teaching*, Integrating Technology Series (St. Paul, MN: 1988).

[30] Northwest Association of Schools and Colleges, op. cit., footnote 20.

[31] Oklahoma Department of Education, "Accreditation of Learning by Satellite Courses," unpublished document, 1988.

[32] Montana Board of Education, op. cit., footnote 24.

Photo credit: Swenson Photo Braham

In some projects using two-way video, no teacher or facilitator is required in the distant classroom.

for teleteachers suggesting techniques for delivering effective personalized instruction via distance learning.[33]

Each of the major organizations now delivering coursework by satellite specifies the skills and training necessary for the site monitors in their systems. Some States have also required facilitator training.

> To use distance learning . . . a school shall verify that local facilitators (not necessarily certified) who assist students in receiving the instruction on-site have adequate preservice training and local supervision.[34]

Course and Teacher Evaluation

Most SEAs have a responsibility for the quality of instruction or instructional materials used in the schools in their States. Two types of rules have been proposed: either that districts show evidence of course effectiveness before adopting distance learning courses, or that districts establish a system to assess the effectiveness of a distance education course during its use.

The Texas Education Agency refers to the responsibilities of districts with the following statement:

> Schools that use alternative delivery procedures . . . should have written policies governing those options. Distance learning . . . should at least

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[33] Minnesota Department of Education, op. cit., footnote 29.

[34] Montana Board of Education, op. cit., footnote 24.

Photo credit: STEP Network

Each of the multistate course providers specify skills and training neccessary for site monitors in their systems. Here Kathy Hansen monitors a STEP Advanced English class at Riverside High School.

have written policies for its governance. Each district's policies shall include responsibility for evaluating the instructional effectiveness of the delivery procedure as reflected by student mastery of intended skills and essential elements. By granting credit, the school district accepts responsibility for the level of student achievement attained in distance learning courses . . . the contracting district, by virtue of granting student credit, can be held responsible for the quality of instruction by distance learning.[35]

Although some States require evaluation of distance education courses, whether this evaluation is the responsibility of the local school district or of SEA, little guidance is given specifying the instruments, criteria, or processes to be used. Missouri provides an exception. (See table 5-1.)

What is noteworthy is the fact that these criteria are generally no more than the standards that would normally be applied to any course, whether traditional or delivered by technology. While holding distance education to the same standard as any other type of education is important if it is to be accepted as legitimate, the unique characteristics of distance education courses warrant additional criteria. These might include topics such as:

- degree of interactivity in the logistical and instructional design of courses and supplementary resources;
- guidelines to help State and local educators in the process of deciding between courses using different delivery systems; and
- criteria for assessing the relative value of live versus delayed interaction.

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[35] Texas Education Agency, *Guide to Distance Learning as an Alternative Delivery Procedure*, GE 7 301 04 (Austin, TX: March 1987).

Table 5-1—Missouri Evaluation Criteria for Electronic Media Courses

The course has been developed on the basis of clearly stated learner outcomes or objectives:

- The course has been developed based on a set of learner outcomes or objectives that are stated sufficiently clearly to communicate to school district staff and students.
- The learner outcomes or objectives are stated in a manner that implies measurement through testing, observation or evaluation of student performance or products (themes, essays, projects).
- The learner outcomes or objectives encompass content comparable to that which would be included in a traditionally delivered course in the same subject and at the same level.

The course is logically organized and developmentally suitable for the grade level(s) at which it is intended to be used:

- The course content appears to be organized in a logical sequence appropriate to the subject and recommended grade levels.
- The course content is developmentally appropriate for age groups or grade levels for which it is intended to be used.

The course includes teaching strategies and resource materials which are educationally sound, address a variety of learning modalities, and are consistent with the learning styles of the age groups for which intended:

- Teaching strategies are varied and intentionally address all three major learning modalities—visual, auditory, tactile/kinesthetic.
- Teaching strategies emphasize those most appropriate to the subject and for the age group for which the course is primarily intended to be used.
- Teaching strategies are consistent with research on effective teaching—i.e., they incude frequent review, guided practice, extensions (enrichment), and correctives (reteaching).
- Textual materials support the stated learner outcomes or objectives, both in terms of content and organization.
- Textual materials are appropriate in focus, vocabulary, and reading level for the subject and grade levels for which intended.
- Supplementary resource materials (either provided or recommended) support a variety of learning modalities.
- Supplementary resource materials (either provided or recommended) support extension (enrichment) and correctives (reteaching) activities.

The course includes both formative and summative tests that are closely aligned with stated learner outcomes or objectives and provides for frequent feedback to students:

- There is a series of formative tests intended to be administered frequently and relating to instruction provided in the immediate past.
- Formative tests are clearly related to and appear to validly assess student performance on a limited number of stated learner outcomes or objectives.
- Formative tests are scored and the results returned to students quickly together with comments and opportunities to discuss individual results.
- There is a series of summative tests intended to be administered periodically which relate to instruction on a defined set of objectives or learner outcomes.
- Summative tests are clearly related to and appear to validly assess student performance on a defined set of learner outcomes or objectives.
- Summative tests are scored and the results returned to students quickly together with comments and opportunities to discuss individual results.

The course has been reviewed by subject matter experts for content validity and objectiveness of presentation:

- The course has been reviewed and found to be valid in terms of content and objective in terms of presentation or reviewers believe the content to be valid and the presentation objective based on their review.

The course has been demonstrated to be effective in achieving stated learner outcomes:

- The course has been used by school districts and found to be comparable to traditional courses in terms of student outcomes.
- The course has been field tested, and results of the field test indicate that it achieves stated student outcomes.
- The course has neither been field tested nor used by school districts, but it is so well developed it should be approved for use in Missouri on a trial basis.

The course includes instructional and technical inservice education for the local classroom teacher:

- The course developers provide comprehensive inservice education on the instructional role of the local classroom teacher in delivering the course.
- The course developers provide comprehensive inservice education in utilizing the textual and nontextual instructional materials provided or recommended for use in the course.
- The course developers provide inservice education in the technical aspects of operating and utilizing all equipment necessary in delivering the course.

The course meets high standards of quality in production and presentation:

- Appropriate production techniques are used to focus on the critical components of the instructional setting.
- Oral communication is clear and understandable; the language is appropriate for the subject and the age or grade levels for which the course is intended.
- The use of music, special effects, graphics, and set design contribute to the overall effectiveness of the instructional presentation.
- Lighting and sound are consistent in level and intensity from scene to scene and contribute to the effectiveness of the presentations.
- The instructor's style, appearance, voice, and movements are natural, pleasing, and contribute to the effectiveness of the presentations.
- The director successfully manages the integration of all production elements to achieve an effective instructional presentation.

Local classroom teacher/monitor qualifications:

- List below the major instructional and noninstructional activities required by the course to be conducted by the local classroom teacher/monitor; the knowledge, skills, or competencies reasonably required to perform each activity at a desirable level; and the qualifications most likely to ensure that a classroom teacher/monitor would possess the knowledge, skills, or competencies.

SOURCE: Missouri Department of Education, "Recommended Evaluation Instrument for Accredited Instructional Programming Via Satellite," unpublished document, February 1989.

Photo credit: Bill Davis, Trinity Productions

Small classes can be combined to use teachers more efficiently. Some States restrict the total number of students enrolled in all sites.

Finally, if distance learning technologies are to move beyond the experimental stage and become options available on a regular basis, States will need to support evaluation efforts. Educators considering the role of distance delivery of instruction need data telling them what needs distance learning can meet, under what circumstances, and at what cost.

Classroom and Instructional Logistics

Although it would seem that classroom logistics are the responsibility of a school district, some States place restrictions on their districts. One major issue in this category is class size. For example:

> Since the teacher at the sending site interacts with, evaluates, and remediates students, the maximum class size shall not exceed 32 pupils per teacher. This may limit enrollment at a given receiving site and it may also limit the number of receiving sites based on the total number of students that are enrolled per hour, per teacher.[36]

In this case, not only is the standing rule on class size in traditional classes extended to distance learning classes at a receiving site, it is further extended to the total number of students enrolled at *all sites* during that time period. This policy indicates the strong belief in the instructional value of small classes and the need to guarantee opportunities for traditional modes of student/teacher interaction. It does not, however, consider alternative ways to provide interaction in distant classes.

Another logistical issue is the use of live versus taped broadcast course sessions. In both Oklahoma and Montana, districts are directed to use live sessions even if it means altering the class schedule. Scheduling is exacerbated when transmissions cross time zones, since a class broadcast from Texas at 9 a.m., for example, would be received in California at 7 a.m., before the school day normally begins. Furthermore, students may lose flexibility in scheduling their other classes at the school in order to accommodate the fixed schedule of a satellite class. Difficulties in coordinating school holidays, vacations, and daily bell schedules have been a barrier to broader acceptance of distance learning classes, and the situation is made even more difficult if live broadcasts must be adhered to at all times.

Credit

State policies regarding student credit may encourage the use of distance delivery of courses, as in this example from Missouri:

> Courses delivered primarily through electronic media may be offered by school districts and counted toward meeting the curriculum standards and State minimum graduation requirements if approved and implemented in accordance with this rule.[37]

Other policies limit the number of courses that may be offered via distance delivery by placing restrictions on allowable credits or in the way that credits are calculated:

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[36] Idaho Department of Education, op. cit., footnote 22.

[37] State of Missouri, 5 CSR 50-340.100, "Department of Elementary and Secondary Education," 1987.

> Credit earned via distance learning is to be limited to 3 units or 6 semester credits for graduation purposes.[38]

> Three units of satellite course credits may be applied toward graduation requirements. Districts designated as isolated may request permission from the Department of Education to offer a fourth unit of credit.[39]

> Superintendents in Minnesota schools considering offering courses to their students via national satellite networks are reminded that these courses are still subject to the State Board of Education Rules, and that these rules require that one credit/hour is equal to 120-clock hours, while the number of hours in a satellite course vary with the different course providers.[40]

State Approval for Courses, Content, and Instructional Materials

Many States require that school districts apply to SEAs for permission to use distance learning programs. In some cases there is a review of courses independent of any district usage, analogous to textbook approvals, resulting in a statewide approved purchase or usage list for curriculum programs. This can be a major hurdle for multistate distance learning projects, with each State having different requirements related to subject matter taught, the scope and sequence of that subject matter, the amount of time devoted to each topic, and what type of credit may be granted for successful completion of the courses. Idaho, Oklahoma, Missouri, and Montana are examples of States that have a formal application process specific to distance learning, especially geared for courses delivered via satellite.

Concern for the content of courses delivered via technology seems to parallel that for standard courses. Content review is part of the approval process. In some cases, this approval requires the use of texts also approved by the State. For example, Oklahoma regulations specify:

> Satellite courses offered for high school credit shall utilize textbooks selected from the Oklahoma approved list of textbooks. Exceptions will be made for advanced placement courses by the Accreditation Section.[41]

These requirements can create barriers to multistate course offerings. As one supplier of multistate courses suggested:

> It is literally impossible to offer a course in which there is a standard text that is used nationwide. Many States pay only for State adopted textbooks so, to the extent an alternative book is used then the local school district has the burden of paying for a new one. This poses a hardship on many school districts and negatively impacts the use of distance learning.[42]

ENCOURAGING INNOVATION AND BROADER APPLICATIONS OF DISTANCE LEARNING TECHNOLOGIES

The policies discussed above tend to be restrictive—protective of State insistence that courses meet minimum standards based on models of traditional instruction. Few States have adopted empowering policies to encourage experimentation based on a new vision for education. **If distance learning is viewed in the context of a restructured education system, new recipes for educational organization are suggested. These issues include alternative funding models, new concepts surrounding curricula and instructional design, and opening doors to new institutional relationships and interstate cooperation.**

Policies could support demonstrations of innovative alternatives to the status quo. For example, most distance learning projects are now funded in the same fashion as other education activities. But creative models have begun to appear. Missouri enacted a tax on the rental of video cassettes to support distance learning activities. The State estimates that approximately $5 million will be raised in the first year.[43] In other States, special bonds have been issued. In still other States, cooperative ar-

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[38] Idaho Department of Education, op. cit., footnote 22.

[39] Arkansas response to the Council of Chief State School Officers Survey, op. cit., footnote 17.

[40] Valdez and Sauter, op. cit., footnote 23.

[41] Oklahoma Department of Education, op. cit., footnote 31.

[42] Otterman and Pease, op. cit., footnote 19, p. 14.

[43] S. 709 stipulates that video rental taxes shall be collected for 5 years. Legislation provides for grants to educational institutions to fund the purchase of technology and instructional programming for both students (courses) and for teachers (inservice training). Betty McCarthey, Missouri Education Satellite Network, personal communication, April 1989.

Photo credit: Bill Ollikkala for Talcott Mountain Science Center

Telecommunications make it possible to offer innovative courses using teachers who come from a variety of backgrounds. Here Dr. Eugenie Clark discusses "Life in an Undersea Desert" on a Talcott Mountain Science Center Interactive Teleconference.

rangements with the private sector have supported the development of the technology base, with users paying for their participation on a subscriber basis.[44] In Oklahoma, the State has provided "small school cooperative grants" totaling $3 million, with approximately $1 million for distance learning), to encourage activity benefiting these schools. In response to this policy, some rural electric cooperatives have contributed satellite dishes to schools in their service areas.[45]

Should funding formulas designed for traditional classroom settings be revised to accommodate the new circumstances of distance learning? What new funding formulas could be devised to provide incentives for cost-sharing across districts or across educational levels? When only contact hours are counted, or bodies in the building, or course units offered over a semester, then technology enhancements that require different instructional time allotments may be impossible. And what of cost-sharing among States?

Similarly, existing State curriculum policies discourage development of new curricula that cross traditional disciplines or grade level boundaries. However, cross-curricular design can be enhanced by distance learning systems that combine the best of many teaching resources beyond what any one classroom teacher could previously offer. How will interdisciplinary or other open-design courses be counted toward State graduation requirements?

Instructional design issues are also neglected. Distance learning technologies, especially when used in combination with computers and other interactive technologies, can offer new instructional possibilities that can and should be reflected in the design of distance learning courses. The expanded use of distance learning technology could contribute to a reawakened concern that questions the qualitative standards of good instructional design. State policy rarely provides incentives to try new instructional approaches, and thus new efforts may never get off the ground despite their potential to improve curriculum.

Interagency Coordination

As discussed above, State legislative planning documents are calling for broad planning and coordination among the various State agencies, communication authorities, and public and private utilities involved in each State's telecommunications systems. Each level of education providers in a State (K-12, community colleges, vocational/technical schools, and universities) also has a stake in these outcomes. SEA's role in planning for future telecommunications services should be clearly articulated. In the case of ever-expanding communications networks, the issue for educational institutions will be: "who controls the highways."[46] **With early and aggressive involvement in the planning process, educational institutions can shape the systems to assure that the specialized needs of education are articulated and receive equal, if not preferred, service.**

There is another motive for increased coordination. The ability to negotiate favorable terms and conditions with competing telecommunications suppliers is enhanced because the education community within a State is likely to be a major user. **Together with other cooperating State and local agencies, educational institutions represent a substantial**

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[44] For example, under an arrangement between New York Telephone and New York State's Board of Cooperative Education Services, the telephone company will develop the infrastructure to link five districts in Long Island, and guarantee a fixed 10-year service and subscription fee. Kevin Fennel, New York Telephone, personal communication, May 31, 1989.

[45] Holt, op. cit., footnote 27.

[46] Rich Gross, Kirkwood Community College, "The Impact of Educational Telecommunications," unpublished manuscript, May 1989.

amount of buying power that can be leveraged in a competitive market to ensure the availability of flexible, cost-effective systems that meet the particular needs of the distance learning community.[47]

TELECOMMUNICATIONS REGULATION AT THE STATE LEVEL

Although the Federal Government has responsibility for setting national telecommunications policy (see chapter 6), States have a large role in developing regulations for provision of telecommunications services within their borders. These in-state telecommunications policies have a large impact on the provision of distance education services.

The State Public Utility Commissions (PUCs) or Public Service Commissions, through their regulation of telephone service and rates within a State, play a growing role in the State distribution of distance learning services that use the telephone lines to transmit voice, video, and data between sites. The rates and policies vary broadly from State to State. As noted in a paper on distance learning:

> At the State level of government, most State PUCs and, in some cases, State legislatures are now grappling with many of the same types of issues regarding the role of competition and regulation that the federal government has grappled with for more than two decades. Some of the issues represent fundamental philosophical concerns, such as whether the concept of "universal service" should be expanded to include access via telecommunications to basic information resources. Other issues center around the introduction of competition. For example, while all states now allow some form of long haul competition, many are struggling with the issue of how much competition, if any, should be allowed for traditional local telephone services. They are also trying to deal with how to fairly allocate costs among competitive and monopoly services, and many states are in the process of deregulating competitive services or relaxing the regulation of services that are at least subject to some competition.[48]

If the rates set by the State PUCs are based on commercial payment expectations, schools may be priced out of the market and find themselves unable to pay for the telecommunications that run their distance learning systems. Basic telephone service is a not insubstantial piece of the yearly budget of schools. When telecommunications needs expand, budgets will be forced to rise. Some have argued that schools should have a special education rate to make it easier for them to take advantage of the advances telecommunications can make to improving education. **The marriage of State concern for education and State telecommunications policy could provide a forum in which schools' distance learning needs and requirements could be given special attention.**

Furthermore, with each State having one or more commissions that regulate telecommunications, it becomes difficult for multistate programming providers and telecommunications companies to coordinate and provide services. What is allowed and available in one State may be available under different conditions in another State, or not available at all. The rapid changes taking place in State telecommunications policies are often difficult to follow, putting a burden on potential service providers to locate and understand the regulations stemming from a myriad of commissions and boards that set the terms under which providers must operate.

The problem is compounded when regional networks are established, linking services across State lines. The regional Bell Operating Companies each serve several States; some are actively supporting cooperative educational networks serving some or all the States in their regions. For example, New England Telephone, part of the NYNEX Corp., is working with Maine, Vermont, and New Hampshire in considering the creation of a Northern States Long Distance Learning Cooperative in which the interactive projects within each State could be linked to provide broader economies of scale. Organizational issues and concerns for "turf" must first be overcome, as well as technical barriers (the three States have each taken different technological approaches to their in-state networks). A third issue is regulatory. Recently the Federal Communications Commission (FCC) changed the criteria for "contamination" of an intrastate circuit, allowing up to 10 percent of an intrastate network's traffic to be interstate without reverting to FCC tariffs. The crossover between State and Federal regulatory telecommunications policy is exemplified in this compromise.

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[47] Gallagher and Hatfield, op. cit., footnote 1, p. 5.

[48] Ibid., p. 8.

Several States have or are in the process of undertaking major studies of their future telecommunications requirements and infrastructure as a means to ensure the competitiveness of industry within the State and to serve social needs across the State.

> These State proceedings and studies are especially important to educators and groups interested in distance learning because their telecommunications requirements are often at the State and local level rather than at the national level. The proceedings are especially important because they will impact on the choices of technology and the prices and terms and conditions under which distance learning delivery systems are available to the education community. It is at the State level where educators can take hold of key policy levers; since education is largely State and local government-controlled, State telecommunications policy should be particularly sensitive to its needs.[49]

SUMMARY

Policymaking in the distance education area is not just education policy, and not just telecommunications policy, it is both. Hence, it is important for individuals from both fields to be involved in the policy process: educators who know what they want and what they need, and technology and telecommunications people who know what is possible and what may be available in the future. It is from the convergence of these two interests that the most successful policies are likely to emerge.

The policies require new perspectives and coordination among all players. As one educator noted:

> Since most of the learning technologies and telecommunications capacities were not invented when many of the policies and regulations were drawn, a particular sensitivity must be placed on the review of laws, policies, and regulations from the transcendent perspective those technologies now afford. For instance, policies, programs and funding sources that support distinct telecommunications systems for home delivery of TV, public library database access and inter-library resource sharing, elementary and secondary instruction and management and postsecondary instruction and management—all in the same community—would be . . . extremely redundant, costly and probably reflect less capacity in all independent cases than might be true if developed as a comprehensive system.[50]

Most distance education policies will be initiated at the State level, since States have primary responsibility for education. Furthermore, many of the telecommunications decisions made by State PUCs will surely shape what educational services can be provided via telecommunications and whether the K-12 education community can afford them.

Nevertheless, national telecommunications policies will also determine much of what telecommunications services States are able to choose from.[51] And, because of the borderless implications of distance learning, there is clearly a role for the Federal Government. The Nation's educational interests would be served if the Federal Government provided assistance to States that need help, enabling them to undertake comprehensive educational telecommunications planning before charging ahead. One form of assistance could be technical assistance, making it possible for States that are further along to share information and technical resources with those States or regions lacking in expertise or experience. The Federal Government could also provide financial assistance to States in the form of planning grants.

Finally, a warning. Unless the education community at all levels makes its requirements and needs known to the suppliers and to the telecommunications policymakers, the schools may not be fully served, students could miss out on the enormous benefits available, and the promise of distance learning may not be realized.

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[49] Ibid.

[50] Gregory M. Benson, Jr., "Technology Enhanced Distance Education: The Promise of New Opportunities for Lifelong Learning in New York State," paper presented to the International Conference on Distance Education, Oslo, Norway, July 1988.

[51] For an extensive discussion of these issues, see U.S. Congress, Office of Technology Assessment, *Critical Connections: Communication for the Future*, OTA-CIT-407 (Washington, DC: U.S. Government Printing Office, in press).

Chapter 6

Federal Activities in Distance Education

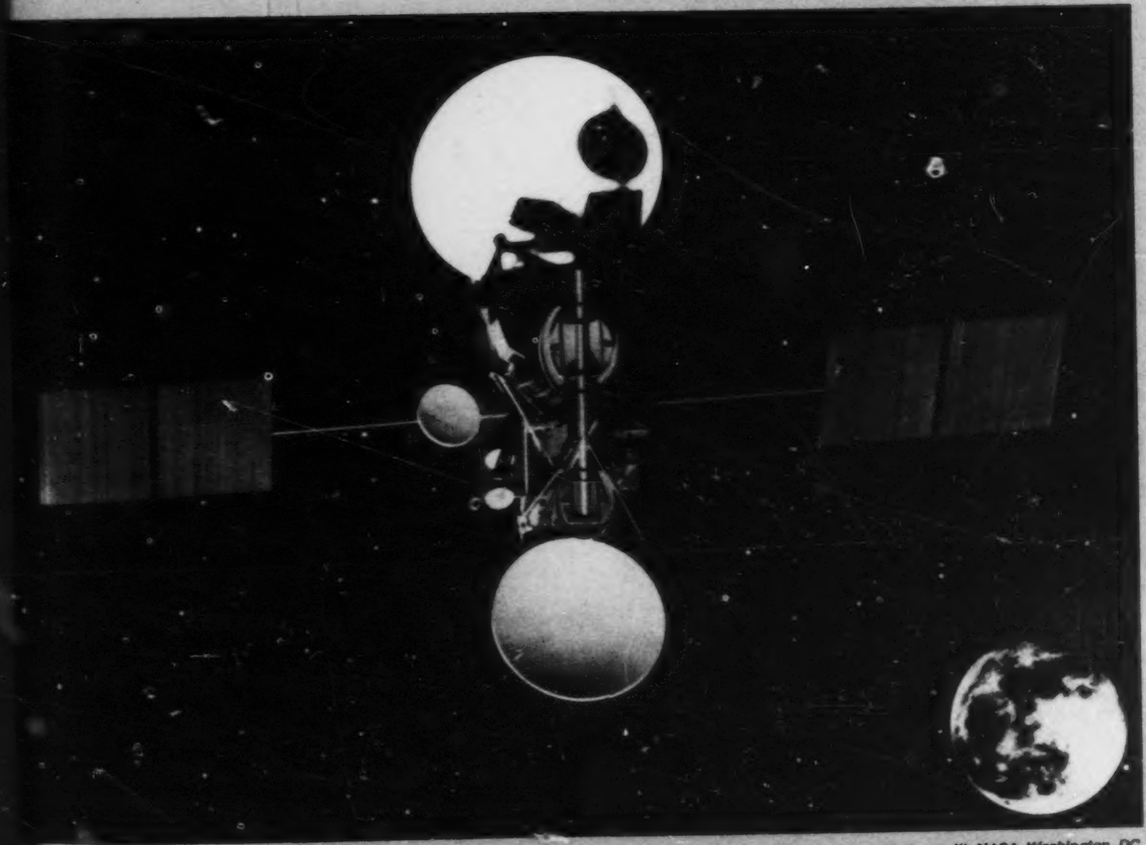

Photo credit: NASA, Washington, DC

Model of NASA's advanced communications technology satellite in orbit

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Chapter 6

Federal Activities in Distance Education

INTRODUCTION

Distance education presents a new set of concerns, challenges, and opportunities to Federal policymakers. These new issues join continuing concerns about equity, access, and quality of education. Distance education places educators in a new marketplace: the volatile and rapidly changing arena of telecommunications. Thus, the Federal Government's relationship to the public education community is expanding. In the past seen primarily as funder, infrastructure builder, guarantor of equality, and priority-setter, the Federal Government's role in K-12 education has evolved to include regulation of marketplace conditions.

This new situation brings new concerns as well as new opportunities. On the one hand, distance learning requires significant front-end expenditures, as well as large investments of time and continued support to integrate these efforts into the school. Such efforts are complicated by the need to purchase hardware and services in a marketplace in which the rules and capacities are changing rapidly.[1] On the other hand, this state of rapid change is favorable toward distance learning. An open, competitive market of suppliers gives groups involved in distance learning an increased opportunity to negotiate favorable terms and conditions for the facilities and services they require.

Growing concerns about work force quality, international competitiveness, and economic development have brought education to the attention of segments of the marketplace never before involved in education. Business and industry are showing an increasing interest in the welfare of our public school system. The Federal Government's interest in education reflect this broadening of concerns.

FINDINGS

- **Federal Government funds have accelerated the growth of distance education in this country, through direct purchasing power as well as the leveraging power of the Federal dollar.** The Star Schools Program (Department of Education) and the Public Telecommunications Facilities Program (Department of Commerce) are the primary Federal programs directly affecting distance education in elementary and secondary schools.
- Other Federal agencies have interests in distance learning through their responsibilities for technology development, training, and education. Yet, no agency-wide strategy or interagency coordination is now in place.
- Federal agencies will have increased opportunities to accomplish agency missions via distance delivery in the near future. The largest providers together can reach a great number of American schools and communities today, and that number will increase in the next few years. Agencies may find distance delivery an attractive way to reach national audiences for a variety of missions including education.
- **Federal telecommunications regulations are central to distance education, because they affect costs, availability, and types of services.** In light of the rapid growth of distance learning, it is time to review and shape Federal telecommunications policies to ensure a more effective and flexible use of technology for education.

FEDERAL ACTIVITIES IN DISTANCE EDUCATION: CURRENT STATUS

The Federal Government is not the basic provider of K-12 education in this country; this role is traditionally exercised by the States and localities. The Federal role in education has been to address particular issues, most prominently equity, access, and national priorities, through targeted funding and research. In 1988, Congress created the Star Schools Program, a comprehensive Federal effort to develop multistate, multi-institutional K-12 distance education. The other impacts of the Federal Government in the K-12 distance learning field are on components such as curriculum, hardware, regulation, research, and infrastructure, or on particular segments of the learner population. These efforts are relatively modest although Federal monies have contributed to many valuable projects.

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[1] These challenges are particularly critical for school districts that would like to use the public telephone network for transmitting video. This most ubiquitous telecommunications infrastructure is still adjusting to the changes brought about by the Modification of Final Judgment. Many of the judgments are being challenged and rethought by the industry, the Federal Communications Commission, and Congress.

Interactive distance learning as described in this report has become a viable resource for American public education only within the last 5 years.[2] It is not surprising, then, that the Federal Government has not articulated any kind of comprehensive distance learning policy. Many Department of Education programs, such as Chapter 1 and Chapter 2 funds, allow use of these funds to support distance learning. However, because of the many pressing needs in the Nation's schools today, and the resistance to or ignorance of this technology on the part of some of the State and local officials, very little of these dollars have been used. Other Federal programs, such as the Rural Electrification Administration's telephone loan program, have funding missions that indirectly support interactive distance learning.

Direct Federal Support for Comprehensive Distance Learning Services: The Star Schools Program

The Omnibus Trade Bill and Competitiveness Act, passed by the 100th Congress in 1988, created the Star Schools Program. It is intended to "... address(es) two critical needs in the rebuilding of our educational system to meet domestic and international challenges. The Nation's students must have access to basic and advanced courses in mathematics, science, and foreign languages, and these courses must be of the highest quality."[3] The amount of $33.5 million was appropriated over a 2-year period.

The Star Schools Act has two major emphases: to create multistate, organizationally diverse partnerships to write and deliver both core and enrichment curriculum; and to create opportunities for disadvantaged students to receive remote instruction.

The Star Schools legislation specifies two formats for the composition of eligible partnerships. In one, membership must include at least one State education agency (SEA), State higher education agency, or local education authority responsible for a significant number of poor or underserved students. Furthermore, this type of partnership is required to have at least two other institutions from a host of types, including the three types listed above, universities, teacher training institutions, public broadcasting entities, and others. The other type of partnership must include a public agency or corporation already formed to operate or develop telecommunications networks to serve schools, teacher training centers, or other education providers. All partnerships must be statewide or multistate. These requirements were meant to create new paths to improving the education system by fostering cooperation between institutions.[4]

The legislation directs at least 50 percent of its funds to school districts eligible for Chapter 1 monies, and, within those districts, to serve poorer schools and other underserved populations.[5] The legislation also requires at least 25 percent of the granted funds be applied to instructional programming, and requires the grantees to generate at least 25 percent of the total budget from non-Federal sources.

The enabling legislation authorized the program for 5 years, setting an overall funding limit of $100 million. For the first round of 2-year grants, 4 proposals were selected from more than 70 applications: Satellite Educational Resources Consortium (SERC), TI-IN United Star Network (TI-IN USN), the Midlands Consortium, and Technical Education Research Centers (TERC). Three of the four projects are satellite-based delivery systems: TI-IN USN, SERC, and Midlands. TERC supplies science and mathematics units using computers and a telecommunications network. TI-IN USN and Midlands are building on already-established networks and/or curriculum; TERC is an existing organization whose Star Schools effort is modeled on a prior project;

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[2] Experiments in interactive distance learning in American public schools dates back to 1971, when the National Aeronautics and Space Administration offered the Office of Education within the old Department of Health, Education, and Welfare free time on its satellites. Three demonstration projects were funded in Appalachia, the Rocky Mountain region, and Alaska; transmission began in 1974. The Appalachian Regional Commission (ARC) project evolved into The Learning Channel, a cable television educational provider. The Rocky Mountain project formed the basis of the Public Service Satellite Consortium. The format for class instruction used by many of today's providers was developed during the ARC project. Kevin Arundel, U.S. Department of Education, personal communication, September 1989. See also Lawrence P. Grayson, "Educational Satellites: The ATS-6 Experiments," *Journal of Educational Technology Systems*, vol. 3, No. 2, fall 1974, pp. 89-124.

[3] U.S. Congress, Senate Committee on Labor and Human Resources, Star Schools Program Assistance Act, Report 100-44, Apr. 21, 1987, p. 1.

[4] Elementary and Secondary School Improvement Amendments of 1988, Public Law 100-297, Sec. 904, Apr. 28, 1988.

[5] Chapter 1-eligible districts are those districts that are adjudged to have at least 10 students living below the poverty level (as determined by the Census Bureau). These school districts are thereby eligible, under a complicated formula, for grants from the U.S. Department of Education. About 80 percent of the school districts in the country are eligible for Chapter 1 funds.

Photo credit: South Carolina Educational Television

Few students had the chance to learn Russian until the SERC Star Schools project brought teachers like Michael Primak and Sherry Beasley to their schools via satellite.

SERC is a new venture. TERC offers curriculum modules for science classes; the three satellite projects offer whole courses in science, mathematics, and foreign languages. All four projects offer teacher training and staff development activities. All will be doing evaluations of educational effectiveness, teacher training techniques, and other aspects of their respective efforts. Table 6-1 gives a broad outline of the four Star Schools projects.

The **SERC** Board of Directors is composed primarily of two representatives from each of the member States: the chief State school officer and the chief executive officer of the educational television network (public broadcasting) in the State. The consortium currently has 19 State members and 4 associate members (Cleveland, Detroit, Kansas City, and New York City). The member States and schools make a significant contribution to the project: State fees are $20,000 for the pilot year 1988-89, increasing to $50,000 for 1991-92. Schools contribute $150 per student per semester course; fees are also charged for teacher inservice courses and events. Schools are required to match 25 percent of the grants for equipment, and must purchase a keypad response system if participating in mathematics classes. Enrollment for the pilot year 1988-89[6] was intentionally limited; SERC had enrolled 4,000 students for courses in 1989-90 as of May 1989. Such demand creates confidence in the SERC management that, even in the face of equipment costs and the inevitable start-up disruptions, schools have a great need for these courses.[7]

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[6] The pilot year was largely funded by a grant from the Corporation for Public Broadcasting; like the other Star Schools grantees, SERC's first full year of operation under Star Schools will be 1989-90.

[7] Gail Arnall, SERC project director, personal communication, May 1989.

Table 6-1—Basic Facts and Figures for the Star Schools Projects

Name	Organizational partners	Primary technology used	Grant amounts FY 1989/ FY 1990	Number of States involved	Number of schools	Number of students
Satellite Educational Resources Consortium	19 States, each represented by the State education agency and the State educational television authority: AL, AR, FL, GA, IA, KY, LA, MS, NE, NJ, NC, ND, OH, PA, SC, TX, VA, WV, and WI; and 4 cities (associate members): Cleveland, Detroit, Kansas City, and New York	Satellite-based transmission; one-way video, two-way audio; C/Ku-band satellite dishes, steerable; unscrambled signal	$ 5.6 million/ $4.10 million	23[a]	312[b]	3,300 (est.)
TI-IN United Star Network (TI-IN USN)	3 State education agencies: NC, TX, and IL; 4 universities: Western Illinois, Alabama-Tuscaloosa, Mississippi State, California State-Chico; the Region 20 Educational Service Center (Texas); and TI-IN, Inc.	Satellite-based transmission; one-way video, two-way audio; Ku-band satellite dishes, mostly fixed, some steerable; scrambled signal	$ 5.6 million/ $4.13 million	10[c]	328[d]	3,200[e]
The Midlands Consortium	5 universities: Alabama-Birmingham, Kansas, Kansas State, Oklahoma, Mississippi; and the Missouri School Boards Association	Satellite-based transmission; one-way video, two-way audio; C/Ku-band satellite dishes, steerable; unscrambled signal	$ 5.5 million/ $4.14 million	5	278[d]	2,500[e]
Technical Education Research Centers	Boston Museum of Science; the Northwest Regional Lab; Minnesota Educational Computing Consortium; City College of New York; Biological Sciences Curriculum Study; and 5 universities: Tufts, Virginia, Michigan, Pepperdine, and Arizona State	Computers connected via commercial computer network	$2.4 million/ $2.04 million	18[f]	447[g]	18,000

[a] 19 States, plus school districts from the 4 cities involved as associate members.

[b] Schools participating through fiscal year 1989 funds only. An additional 121 schools are receiving teacher inservice and student seminars only.

[c] The number of States with 4 or more sites. There are 12 other States where TI-IN USN has 1-3 schools. Most of these schools are Bureau of Indian Affairs (BIA) schools whose TI-IN USN activities are being coordinated through BIA.

[d] Schools that are or will be participating through fiscal year 1989 and fiscal year 1990 funds.

[e] In addition to these students, other students at non-Star Schools sites will take classes developed with Star Schools money.

[f] The number of States with 4 or more sites.

[g] Schools participating in school year 1989-90 only.

SOURCE: Office of Technology Assessment, 1989, based on information provided by the Star Schools projects and the U.S. Department of Education.

TI-IN USN is a consortium that includes three SEAs, four universities, a regional State education service agency, and a private for-profit company already providing satellite-delivered curriculum, TI-IN Network, Inc. (TI-IN). TI-IN has been providing whole course curriculum and staff development programming since August 1985; six of the other partners will also develop programming during the 2-year period of the grant. Participating schools will be required to pay a subscription fee of $3,650 for 1989-90, as well as a per student fee of about $240 per semester course. TI-IN sends a scrambled satellite signal to participating schools, and, for the 244 schools receiving equipment in the first year of the grant, provides a fixed-placement satellite dish. The schools receiving equipment from the second-year funding under the Star Schools Program will have steerable dishes. Although these dishes are more expensive to purchase and maintain and more troublesome in signal quality, TI-IN believes that these schools would benefit from the added programming available, both interactive and broadcast.[8]

The **Midlands Consortium**, composed of universities in four States plus the Missouri School Boards Association, is a five-State effort to deliver satellite-transmitted secondary curriculum, inservice programming, and staff development programs. Like TI-IN, Midlands will build on an already existing core of schools, curriculum, and hardware, primarily from Oklahoma State University's Arts and Sciences Telecommunications Service (ASTS). Unlike TI-IN, Midlands is managed more like four independent networks than like one coordinated network. For example, Star Schools money will go, in full or in part, to install downlinks at 164 schools in the 5 States. The schools are required to keep a log of the use of the dish, and required to offer one high school course or 50 hours of other programming; this requirement, however, does not need to be met with Midlands-produced programming. A number of the Midlands schools have planned to use the dishes to pull in C-SPAN, The Learning Channel, and other cable programming not otherwise available to them.

The consortium partners who will be producing programming—Kansas, Kansas State, and Oklahoma State Universities, and the Missouri School Boards Association—will independently produce, price, and market their programming. Any school in the country can tune their satellite dish to this unscrambled programming; however, if students or teachers are to receive credit toward degrees or certification, they must register with the consortium. The consortium provides assistance to its members in technical areas as well as instructional design, particularly from ASTS to the other partners.[9]

The **TERC** Star Schools Project uses a computer and a commercial teleconferencing network to connect students studying science or mathematics. The curriculum approach is to engage students in data collection and problem solving, exchanging observations and data with other classrooms around the country. The telecommunications network, basically an electronic mail network, allows students to share results, write reports, and ask questions of leading scientists who are serving on the project as models and collaborators. For example, one of the units will be on weather. Core activities will include the gathering of weather data at sites around the community, sharing this data with schools around the country, and analyzing fluctuations and unexpected differences. This data collection may be of utility to weather researchers and meteorologists, such as the National Oceanic and Atmospheric Administration. The schools are responsible for providing the computer, modem, and telephone line for the project, although some subsidies are available. Teacher preparation, software, scientific experiment supplies, and telecommunications are paid for by TERC and the teacher training center partners. The overall hardware costs (one computer per two classes) and telecommunications costs (computer network hookup at off-peak hours) are very low relative to any video-based distance education efforts. TERC estimates that 18,000 students will participate in the project in 1989-90.

In the TERC program, the classroom teacher remains the subject expert; in the other three projects the teleteacher provides most of the instruction, supplemented by the attendant classroom teacher. Therefore, inservice teacher training is considered an especially critical component to the TERC model, and is being carefully designed and evaluated. The

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[8] Lloyd Otterman, chief executive officer, TI-IN Network, Inc., personal communication, May 1989.

[9] Constance Lawry, associate director, Arts & Sciences Extension, Oklahoma State University, personal communication, May 1989; and Jerry Horn, associate dean, College of Education, Kansas State University, personal communication, May 1989.

Photo credit: Jones Gee

Hands-on science, problem solving, and cooperative learning are spinoffs of what students experience as they work in this TERC Star Schools module, which challenges them to design a structure with limited materials.

TERC partners are acting as resource centers; teacher training and support is the primary function of these centers.[10]

With the exception of two pilot projects, the Star Schools networks did not commence their full-scale efforts until September 1989. Thus, although the first round of Star Schools grants is expected to have a significant impact on distance education, much of that impact will not be known for a number of years. Still, some impacts can be seen:

- Approximately 30 percent of rural and isolated high schools will have a satellite dish by the end of 1990;[11] of that number, approximately one-third will have been purchased and installed using Star Schools money. While different dishes will have differing capacities, it is safe to assume that these dishes will have the ability

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[10] Cecilia Lenk, project director, TERC Star Schools, personal communication, September 1989.

[11] Lloyd Otterman, TI-IN Network, Inc., makes these estimates based on the following figures (all approximate): there are 5,930 rural school districts (based on Department of Education figures), and another 4,810 that are isolated (as defined by census tracking), for a total of 10,740 districts. By 1990, Otterman projects that TI-IN will have at least 900 schools with satellite receive dishes, SERC will have about 600, Midlands/ASTS will have 400, Kentucky will have close to 1,000, and STEP will have 150 for an estimated total of better than 3,000 schools. (These numbers do not include the possibility that Whittle Communications' Channel One program may install up to 8,000 high schools with satellite dishes in the next 1 to 2 years. Some of these schools will likely be rural or isolated.) Because a great majority of rural and isolated school districts have only one high school, it is Otterman's estimate that at least 30 percent of rural high schools will have dishes.

to provide these schools with course enrichment segments and some whole courses for the foreseeable future. Even if one or two of the Star Schools satellite networks were to disband in the future, the large installed base of satellite dishes creates a market that will not be ignored.

- **One of the primary goals of the Star Schools legislation—to create multistate, multiorganizational partnerships in education—has been realized.** These relationships between universities and local schools, SEAs and public broadcasting entities, and others, across and within States and regions, have the potential to provide each participant with a rich network of expertise and ideas.
- The first round of Star Schools funding has gone predominantly to support satellite-based delivery systems. None of the Star Schools projects uses fiber optic cable, digital (T1) cable, microwave, or Instructional Television Fixed Service (ITFS) technologies as the transmitter of the video component of the programming. This narrow focus missed an opportunity to spur the development of systems and markets.
- **Star Schools money stimulated a majority of States and/or districts in States to consider distance delivered instruction.** Some States have moved forward to implement or explore such instruction, seeking funds from sources other than the first round of the Star Schools Program.[12] This groundswell of interest, enhanced by 2 subsequent years of planning and problem solving, should manifest itself in an even greater interest in the second round of Star Schools funding.
- Because of the 25 percent matching requirement built into each Star Schools grant, and the amount over and above contributed by States and others, it is estimated that Star Schools has resulted in a total capital investment in education of about $42 to $47 million.[13]

Federal Support for the Distance Delivery Infrastructure

Federal Agency Grant Programs

Some Federal funds support the distance delivery infrastructure through programs targeted for telecommunications technologies. In the following two examples, from the National Telecommunications and Information Administration (NTIA) and the Rural Electrification Administration (REA), the monies are primarily directed to support public broadcasting facilities and rural telephone facilities, respectively. Because distance education can be delivered through a variety of technologies, NTIA and REA funds are an important element in the support of the infrastructure.

The **Public Telecommunications Facilities Program (PTFP)** at NTIA (U.S. Department of Commerce) funds equipment purchases and some planning grants for broadcast (public television and public radio) as well as nonbroadcast (noncommercial providers using ITFS and cable, for example) telecommunications facilities.[14] The annual appropriation was $18 million in fiscal year 1988. Priority is given to applications that equip new public television and radio facilities, both broadcast and nonbroadcast, or to extend service to new areas. The next priority is given for replacement of outdated and outmoded equipment. While no rules are set on the amount to be spent in each area, these priority applications tend to account for about three-quarters of the PTFP granting budget. The remaining funds are used to support innovative projects and minority access. It is from this part of the pool that NTIA has provided funding for equipment used in interactive distance learning efforts. In 1988, this program funded nine special nonbroadcast projects at a level of $2.25 million (12.5 percent of the PTFP budget). These grants include funding for the purchase of equipment for two satellite uplinks, three new ITFS systems, expanding service for two established ITFS systems, a microwave system, and captioning systems to increase access to telecommunications programming for the hearing-impaired. The grantees include community colleges, universities, a county office of education, and community telecommunications networks (i.e., organizations formed specifically to provide these services).[15]

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[12] See, for example, The Iowa Educational Telecommunications Plan. The Iowa legislature appropriated $50 million over the next 5 years to install a statewide fiber backbone that links the State universities, community colleges, and public schools. Linda Schatz, Iowa Public Television, personal communication, May 1989. Other efforts include the Vermont/New Hampshire/Maine Northern Tier Network, which came out of Star Schools proposal planning.

[13] The 2 years of Star Schools funding totals about $33.5 million in Federal funds. The matching requirements leveraged more than 25 percent from some of the projects. Cheryl Garnette, Star Schools Program, Educational Networks Division, Office of Educational Research and Improvement, U.S. Department of Education, personal communication, September 1989.

[14] The predecessor of this program, called the Educational Broadcast Facilities Program, was originated in 1962 and was administered by the Office of Education, at the Department of Health, Education, and Welfare. In 1978 the program was expanded to include nonbroadcast components and to fund planning efforts; in 1979 the program was moved to the Department of Commerce. Originally the program allowed some funding for programming, although now the funds are reserved for equipment and planning. Frank Withrow, Star Schools Program, Educational Networks Division, Office of Educational Research and Improvement, U.S. Department of Education, personal communication, July 1989.

The **Rural Electrification Administration (REA)** (U.S. Department of Agriculture) offers direct loans, federally established bank loans, and guaranteed loans to both rural electric and rural telephone companies. In fiscal year 1988, the REA telephone division made loans or loan guarantees of $273 million, of which $193 million were in the form of 5-percent interest direct loans. The direct loan fund and the Rural Telephone Bank loans are both revolving funds; i.e., all payments received by the fund are available to be reloaned. The REA loans to rural telephone companies are authorized to finance telecommunications equipment that extend telephone services. This mandate does not exclude educational television applications, but the limitation of traditional copper cable (i.e., not enough bandwidth to transmit video) has greatly limited the number of loan applications REA received in the past with educational components. However, with the advent of fiber optic cable and its significant capacity for video, voice, and data, REA has seen an increase in applications for such loans. When a telephone company is laying fiber cable, dedicating lines for the school system and connecting from the trunk to the school itself is relatively inexpensive. One REA official estimates that the cost of laying the additional cable to the school is $1,500 per mile during initial trunk line installation, but $10,000 if such cable is laid at some future date.[16]

There are no separate funds for educational efforts per se, but projects in rural Minnesota, the Oklahoma Panhandle, and the Papagos Indian reservation, among others, have been supported by loans to the rural telephone companies in these areas. REA encourages telephone companies to work with school districts as a way of cost sharing, but does not solicit specific projects for education.

Through NTIA and REA, significant government resources are being invested in the national telecommunications infrastructure; in some projects, this investment serves the educational needs of the community. These funds represent a significant resource for the education community. These resources offer the interactive distance learning community limited (NTIA) or indirect (REA) support. Changes in the scope or direction of these programs could expand the resources available.

Department of Education Programs

There are other examples of Federal monies that support the distance education infrastructure. The Department of Education has many programs that address concerns of equity, access, advancement, and special populations. **Many of these programs allow use of funds for distance delivered education efforts, although to date few of these funds have been tapped for this purpose.**

Chapter 1 funds, $4.5 billion in fiscal year 1989, are provided to assist "educationally deprived children"[17] in elementary and secondary schools. The eligibility and allocation formulas essentially limit Chapter 1 funds to only this population—poor and disadvantaged children. Ninety-nine percent of these funds go to local education agencies for the targeted population. A high percentage of Chapter 1 funds go to elementary schools.

Because most distance delivered whole courses are targeted to higher-level classes in high schools, and because many disadvantaged children are not high academic achievers, Chapter 1 funds have not played a significant role in distance learning in this country to date. However, the mandate in the Star Schools legislation that at least 50 percent of its funds benefit Chapter 1-eligible schools may serve to leverage more Chapter 1 funds for distance education. Ongoing costs such as per-student fees and supplies will be increasingly paid for out of Chapter 1 funds. Enrichment classes, course modules, teacher training activities, and staff development activities may become accessible and relatively inexpensive in light of a school's existing system capacity.

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[15] Dennis Connors, National Telecommunications and Information Administration, personal communication, Apr. 3, 1989.

[16] Robert Peters, Rural Electrification Administration, personal communication, March 1989. An industry expert believes these estimates may be closer to $2,500 per mile now versus $8,000 later, although such numbers contain considerable variables. Joe Arri, Bellcore, personal communication, August 1989.

[17] Elementary and Secondary School Improvement Amendments of 1988, Public Law 100-297, Sec. 1001, paragraphs (a)(2)(A) (Declaration of Policy) and (b) (Statement of Purpose), Apr. 28, 1988.

Certain Department of Education programs have limited activities in support of distance education. The Federal, State, and Local Partnership for Educational Improvement, commonly known as Chapter 2, is the consolidated funding mechanism for dozens of previously separate directed pools of money. Chapter 2 funds are rarely used for any telecommunications technology or training. Eighty percent of these funds, $463 million in fiscal year 1989, are distributed to the local education agencies through the States. States and local education agencies are allowed to spend the funds in any of six broadly sketched areas, which gives the agencies a great deal of flexibility. The Department of Education and the State education authorities are prohibited by statute from influencing the decisionmaking of the local education agencies on how to spend the money; this provision protects the local autonomy of the program.[18]

Money distributed under Title III of the Higher Education Act, dedicated to maintain the self-sufficiency of higher education institutions, funds universities and colleges in many areas, including facilities and technology. In fiscal year 1989, the Title III program budget was $140 million, which included $23 million in new starts.[19] These funds affect the K-12 education community through the connection between institutional outreach and advanced high school coursework, one of the primary uses of distance education. For example, the University of Maine system received a 5-year, $4.4 million grant under Title III to fund the statewide Community College of Maine/Telecommunications System. Central to expanding access to advanced educational programming in the State is connecting every high school to the system.[20]

The Secretary's Fund for Innovation in Education ($14.7 million in fiscal year 1989) is a new fund offering grants in four areas—innovation in education, technology, health education, and computer-based instruction. The technology funds, limited in 1989 to $1 million in continuing projects, are currently being used to support television and radio broadcasting efforts. The computer-based instruction category awarded between $3 to $4 million in fiscal year 1989.[21]

Department of Education Technical Assistance: The Regional Education Laboratories

The Department of Education charters and supports nine regional educational laboratories. Each laboratory is governed by representatives of SEA and local education agencies, business, school board members, and other affected parties. These laboratories attempt to bridge between research and practice, bringing into the field important findings, techniques, evaluations, software, and other services to support the practitioners in their region. The Department of Education provided $17.2 million for the laboratories in 1989, plus an additional $5.2 million for an initiative on rural small schools. The laboratories draw additional funds from the States, foundations, and contracts and grants, including other Department of Education funds. The laboratories can be an important resource for distance learning projects. In North Dakota, State planning activities and technical assistance for three model projects have been supported by the Mid-Continent Regional Educational Laboratory (MCREL). In fall 1990, MCREL will launch a model "magnet school without walls" for advanced mathematics and science high school students in South Dakota. Videotapes produced by the Annenberg/Corporation for Public Broadcasting project and audiographics instruction provided by the University of South Dakota make up the school's curriculum.[22]

Mission-Related Federal Activities

Many Federal agencies have educational components in their missions. These efforts allow agencies to raise awareness among the Nation's schoolchildren about aeronautics and space (National Aeronautics and Space Administration—NASA), agriculture and agribusiness (U.S. Department of Agriculture—USDA), and law and the police (the Department of Justice), to name just a few. For these agencies, the very missions they pursue are the curriculum they propagate. Most often, these programs are developed to be modules or units within traditional K-12 curriculum. Some of these agencies use distance delivery of their materials; others, such as the Department of Justice, have not, or have deemed it inappropriate to their mission.

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[18] Robert Kastner, Division of Formula Grants, Office of Elementary and Secondary Education, U.S. Department of Education, personal communication, July 1989.

[19] Stanley Andrews, Division of Institutional Development, Office of Postsecondary Education, U.S. Department of Education, personal communication, June 1989.

[20] Pamela MacBrayne, executive director of distance education, University of Maine at Augusta, personal communication, May 1989.

[21] Shirley Steele, Fund for the Improvement and Reform of Schools and Training, Office of Educational Research and Improvement, U.S. Department of Education, personal communication, June 1989.

[22] Paul Nachtigal, Mid-Continent Regional Educational Laboratory, personal communication, September 1989.

Distance education can be an effective system for accomplishing a mission. For NASA, the technology inherent in distance education, primarily satellites, has been part of its research and development effort for more than 30 years. For NASA, both the medium *and* its mission are the message. NASA launched the first communications satellites used for education in 1974; the first satellite-delivered NASA educational effort was images from the Voyager mission to Jupiter in 1979 and Saturn in 1981. Universities, science centers, and planetaria received these images as they were returned from the spacecraft, accompanied by presentations from NASA scientists. In April 1985, NASA ran a pilot project entitled "Mission Watch," in which scientists aboard the Space Shuttle discussed their experiments and answered questions from students and teachers. This highly successful pilot was to be the model for daily classes from the Teacher-in-Space Program during the Challenger flight that ended in a tragic explosion. The two overview videoconferences that were held one day prior to the accident had an estimated viewing audience of 2 million students and teachers.

For the last 2 years, NASA has produced an educational videoconference series, "Update for Teachers," in conjunction with Oklahoma State University. These four, 1-hour programs provide elementary and secondary teachers with space science activities, experiments, and strategies for the classroom. An extensive question-and-answer period is part of each videoconference. Prior to each broadcast, NASA distributes written material to participating teachers describing classroom activities, related publications, and broadcast information.

In addition, videotape segments have been uplink
to schools for taping immediately after the vide
conference. NASA estimates that 20,000 teache
from all 50 States viewed the November 19
conference on "Living In Space." NASA's futu
plans include conducting a live lesson from spa
sometime in the next 1 to 2 years, and at some po
reviving the "Mission Watch" concept for t
Teacher-in-Space program. In the more dista
future, NASA sees the space station as the base f
a variety of exciting educational opportunities.[23]

Distance delivery methods are being used
contemplated for special projects in USDA. T
National Agriscience Ambassador, funded throu
the Special Programs Office of the Cooperative Sta
Research Service, organized a February 1989 tel
conference on careers in agriscience which w
viewed by an estimated 2 million students.[24] T
Extension Service is using interactive video
convey information about land issues and t
Department's services.[25]

USDA has a mature administrative audio- a
videoconferencing system, used to connect hea
quarters with the vast network of regional admini
trators and Extension Service agents. USDA us
distance delivery methods for their elementary a
secondary educational efforts only in isolated case
as described above. USDA, primarily through t
Extension Service, has developed a highly dece
tralized, inexpensive partnership with States, cou
ties, and local organizations that is reaching millio
of students very effectively, without technology.

Federally Funded Curriculum Developmen

The Department of Education and the Nation
Science Foundation (NSF) have missions targeted
improving quality and access of education for K-
students. NSF has the lead role in the Feder
Government's efforts in science and mathemati
education, while the Department of Education
mandate is based on providing access to education
opportunities for the entire spectrum of students,
well as curriculum improvement efforts across a
subject areas. Both agencies have funded curriculu
development projects for distance education.

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[23] William D. Nixon, National Aeronautics and Space Administration, Educational Affairs Division, "NASA Distance Learning—Satell
Videoconferencing for Education," unpublished document, May 17, 1989.

[24] Deborah Harris, Louisiana Educational Satellite Network, Southern University-Shreveport, personal communication, February 1989.

[25] Tom Tate, Extension Service, U.S. Department of Agriculture, personal communication, February 1989.

The Star Schools Program, described previously in this chapter, gave grants totaling $33.5 million, of which at least 25 percent is to be applied to instructional programming, as required by the enabling legislation. The legislation specifies instruction in mathematics, science, and foreign languages; whole courses, modules, inservice training workshops, and staff development seminars are being developed by the Star Schools grantees.

NSF's efforts in distance education have so far been the funding of a limited number of projects that extend the technology in unique ways. NSF, through its Materials Development, Research, and Informal Science Education Division, Directorate of Science and Engineering Education, has funded applications using telecommunications to deliver instruction. Grants are available for curriculum development, hardware purchases, and development of advanced technologies. Examples of recent projects include the Jason Project, a seafloor exploration project headed by Titanic discoverer Robert Ballard (see chapter 1, box 1-E). NSF spent a total of about $1 million on the Jason Project, both for hardware purchases for the 12 science centers and museums that served as downlink sites, and for the science curriculum developed by the National Science Teachers Association. NSF also provided funding to TERC for the Kids Network project, science enrichment curricula using computer networks that is the precursor to the TERC Star Schools project. Currently, NSF is funding curriculum development for an Advanced Placement chemistry class being developed by Oklahoma State University.[26]

Federally Run or Managed Schools

In a few circumstances, the Federal Government is responsible for actually running K-12 schools. The Department of Defense Dependent Schools (DoDDS), for example, has the responsibility for basic education for 155,000 schoolchildren living in military installations in 32 countries. At that size, DoDDS ranks as the ninth largest school district in the country. The Bureau of Indian Affairs (BIA) directly operates 182 schools in 27 States; tribes and tribal organizations operate 71 of the schools through a contract with BIA.

Photo credit: Craig D. Lewis

The Eastern Navajo Agency Network links students from Native American schools around the country.

Both of these government-run school systems are beginning to use electronic networks for education; use of video-based distance delivery systems is rare at the present time. DoDDS is installing a management information system in its schools and administrative offices around the world. Until that fiber-based system is in place, no comprehensive efforts using the telecommunications infrastructure for education will likely occur.[27] However, grassroots initiatives have already emerged in the DoDDS system. DoDDS students in West Germany have participated in Interactive Communications Simulations developed by the University of Michigan.[28] The Pascal computer language is taught to DoDDS students in Germany, Okinawa, Korea, and Italy via computer network. The teachers communicate with students solely through the network, feeding messages, homework and tests through a University of Michigan computer. DoDDS schools in England, Japan, and Bermuda have expressed interest in participating in the future.[29]

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[26] Michael Templeton, Andrew Molnar, and Mary Kohlerman, Materials Development, Research and Informal Science Education Division, Science and Engineering Education Directorate, National Science Foundation, personal communications, March-May, 1989.

[27] Dennis Bybee, Department of Defense Dependent Schools, personal communication, December 1988.

[28] See ch. 2, footnote 26.

Currently, 19 BIA schools are part of the TI-IN Star Schools effort.[30] In this project, the schools will be outfitted with a satellite dish and connections for $75, and will then pay TI-IN $240 per student per course that they purchase from the TI-IN menu of courses. BIA is committed to funding these schools' continued access to distance learning courses.

The other key BIA effort is the Eastern Navajo Agency Network (ENAN), a computer network that will be hooked into most of BIA's 182 schools by October 1989.[31] This network includes a student "pen pals" section, an administrators network, an effort to share culturally relevant teaching strategies (developed at Northern Arizona University), a beginning teachers network (starting in fall 1989), and a mathematics/science master teachers network (involving 70 teachers and professors from the University of Kansas and the University of New Mexico). Teachers in these isolated settings are able to share instructional strategies, particularly in mathematics, science, language arts, and foreign languages. Also, teachers who participate in BIA's summer inservice institutes are encouraged to keep in touch via the network. BIA is particularly concerned about the isolation of teachers in Native American schools. The summer institutes and ENAN are considered critical elements to improving the quality of teaching. Also, some BIA schools recently began experimenting with the Pennsylvania Teleteaching Network, an audiographics teaching system headquartered at Mansfield University.[32]

The Bureau is encouraging tribes and tribal organizations to more directly control the education of Native American children; the management of 39 percent of the BIA schools has already been contracted out.[33] Distance education delivery systems can be key resources for retaining and reinforcing the cultural context of Native American schools. Distance education can overcome cultural as well as geographic barriers, by grouping students with cultural peers around the country. This expansion of the base of students offers the advantages discussed previously in relation to geographic isolation: a broader array of information, curricular, and human resources necessary to improve educational quality.[34]

Federal Training Efforts and Their Relevance to Distance Learning

The Federal Government is one of the largest trainers in the world, spending an estimated $18 to $20 billion a year to train both its civilian and military personnel,[35] and distance delivery for training has been used extensively for a number of years. Such efforts, both in the Federal Government and private industry, shed light on technical and classroom management models that could be effective in the K-12 classroom, and in the professional development and training of educators.

Federal networks for training and management communications are important because they are national or regional. As such they have the potential to serve secondary users, such as the elementary and secondary education communities, with facilities and expertise that are already in the public domain. Also, Federal and State policymakers participate in many audio and video teleconferences; this involvement tends to demystify such technologies for the very officials whose attitudes can have significant influence on distance learning efforts.

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[29] It is estimated that one-third of the 270 Department of Defense Dependent Schools have started some telecommunications activity for instruction. Sam Calvin, Department of Defense Dependent Schools, personal communication, August 1989. See also Kent Appelgate et al., "Pascal Via Telecommunications: Using Low Tech for High Tech Results," presented at the International Symposium on Telecommunications in Education, August 21-24, 1989, Jerusalem, Israel.

[30] Sixteen of these schools are working directly through the Bureau of Indian Affairs; the other three are contracted through the other TI-IN partners, or were identified and included through involvement with the State education agency.

[31] Paul Resta, Center for Technology and Education, University of New Mexico, personal communication, Aug. 31, 1989.

[32] For a full description of the Pennsylvania Teleteaching Network, see Bruce Barker, Texas Tech University, "Distance Learning Case Studies," OTA contractor report, April 1989.

[33] Bill Mehojah, chief, Elementary and Secondary Education Branch, Bureau of Indian Affairs, U.S. Department of the Interior, personal communcation, July 1989.

[34] Jason Ohler, University of Alaska Southeast, "Distance Education and the Transformation of Schooling: Living and Learning in the Information Age," OTA contractor report, May 1989.

[35] Tony Carnevale, Vice President of National Affairs, American Society for Training and Development, personal communication, July 1989.

In addition to training and telecommunications networks, interactive curricular materials and research relevant to distance-mediated instructional design are produced extensively for and by the Federal Government, and thus are public property. These materials are primarily for training, although some of it is relevant to education, as are many authoring systems for curriculum development. For the educational community to make use of these materials, however, evaluation, modification, and distribution of materials needs to be performed.

Federal Training Networks: Models of Distance Learning Technologies

Existing Federal training networks using distance delivery of course materials can serve the K-12 education community in two ways. One, they can serve as a model of distance delivery used in the public sector. Secondly, Federal networks provide an existing hardware base that could be used by the education community to extend their service to more learners.

The Department of Defense (DoD) has a vast and diverse learning audience, and thus employs numerous distance learning networks. One example is the Army Logistics Management College (ALMC), which has been offering one-way video, two-way audio courses over its Satellite Education Network for over 4 years. The college offers nonclassified, American Council on Education-accredited courses to both civilian and military defense personnel; courses are offered for other branches and subdivisions of DoD. Of the 57,000 students who have taken courses from ALMC in this 4-year period, 13,000 have been remote learners. Evaluation data show no

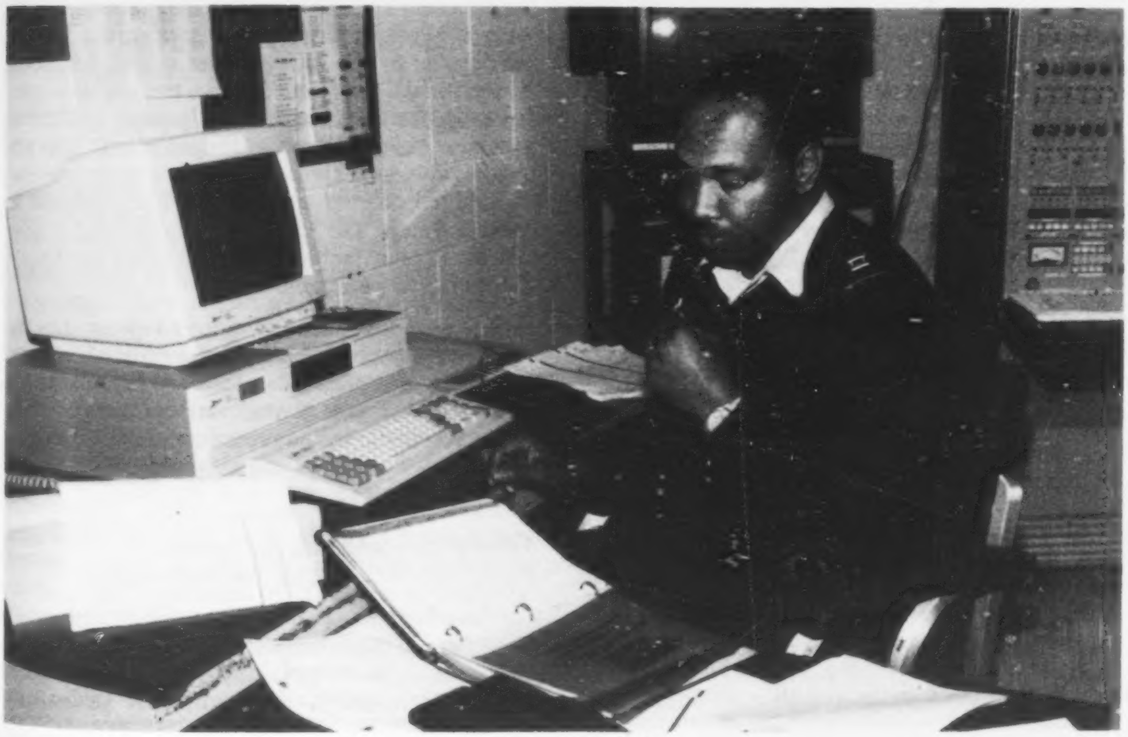

Photo credit: U.S. Army, Ft. Lee, VA

The military has used distance learning to train personnel for many years. Transferring this experience and investment in technologies to the Nation's classrooms could be a tremendous boon to schools.

significant difference between remote and on-site instruction.[36] The college estimates that it saves $1,500 per remote student versus an on-site student; most of the savings comes in the form of travel costs. These findings are similar to findings in private sector training applications of distance learning systems. In spite of severe budget cuts at ALMC in the last year, the college hopes to expand its efforts to include more uplink and downlink sites.

ALMC provides a useful example of the opportunities and barriers to distance learning efforts in the Federal Government and in the public school system. The college is able to share its expertise and facilities with others in DoD, and is exploring the possibility of providing at-cost services to local education users as well. Such interconnections provide for cost-efficient use of hardware and facilities, and may provide an increased basis for justification of budgets.

Because of the present budget climate, Federal program managers report that it is difficult to convince superiors and Congress that avoiding program budget increases is as valuable as reducing program budgets. Many distance delivery systems, such as the ALMC Satellite Education Network, can increase range and quality of programs for little or no extra money. However, many budget-setters are concerned about cutting costs, not improving or increasing services for the same dollars, and this is hampering the ability of successful systems to increase savings from economies of scale and efficiency of management.

Also of note within DoD is an effort in the Department of the Army to plan a comprehensive training strategy. The Army has a massive training mission, a mission that has become even more acute in the past decade as more and more responsibilities have been transferred from the active Army to the Army Reserves. Reserve forces are difficult to adequately train because they are dispersed throughout the country (4,600 reserve unit sites) and are available for only 39 days per year.[37] Added to this is the training of the National Guard, another large force dispersed in location and short on time.

The Army has embarked on the development of a comprehensive training strategy to serve these and other missions; the stated goal is to reduce the amount of local training by 50 percent by the year 2020. The Army is focusing on models that allow for a selection of media, depending on the particular course or material that needs to be conveyed.[38] One of these models is the TRAINS system (the Training Reserves Active component Integrated Network System), which uses off-the-shelf technology to provide the capability for video, audio, and computer teleconferencing, and allows the instruction to reach into private homes as well as remote instruction sites. This system will be pilot-tested in the coming year.[39]

The Army Reserves and National Guard represent a large, dispersed and varied segment of the population. The geographic spread of the reserve component of the Army mimics the spread of schools and communities throughout the country. Resource- and facility-sharing could occur between schools and the Armed Forces Reserves, especially because reserves would tend to use such services during nonschool hours. In fact, the Army Reserve training managers have discussed the feasibility of putting a TRAINS system in every high school in the country. The high schools could use these systems to receive satellite-transmitted courses and services from national or local providers. The Army and National Guard could use the school facilities and TRAINS system on evenings and weekends.[40]

This kind of resource sharing is suggested by the cost of the equipment, as well as the cost of facilities to serve as downlink sites. Potential benefits to the schools include cost savings and increased community involvement in and commitment to the schools; potential risks include the inevitable conflicts between organizations that share resources.

Federal Teleconferencing Networks: Policymakers Learning via Technologies

Many Federal agencies, like their private-sector counterparts, use teleconferencing to improve communications between multiple regional offices and headquarters, and realize significant savings on travel. For example, USDA has an audio and video teleconferencing network in place which produces approximately 1,500 audio conferences and 12 video conferences a year, all from one studio at USDA headquarters in Washington.[41] The USDA system is exemplary for its growth pattern (gradual, user-driven) and its service characteristics (high-quality service, allowing technology to become transparent to the users).

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[36] John Brockwell, Army Logistics Management College, personal communication, September 1989.

[37] James S. Cary, U.S. Army Training Support Center, "RIMS System Description," unpublished report, January 1989.

[38] Millie Abell, U.S. Army Training and Doctrine Command, personal communication, August 1989.

[39] James S. Cary, U.S. Army Training Support Center, personal communication, January 1989.

[40] Ibid.

In another example, the Nuclear Regulatory Commission (NRC) has recently established a teleconferencing network between its Washington headquarters and its seven regional offices around the country. It took only 8 months to implement the system from the first demonstration of the possibilities to an NRC senior administrator.[42]

As teleconferencing becomes a more ubiquitous communications tool, Federal managers may be affected by and thus affect the distance learning environment in this country. Particularly, the installed base of satellite dishes may provide both the government and education communities with sharable resources and expertise.

Technology Transfer: Dissemination of Distance Learning Technologies and Curriculum

The Federal Government is one of the largest creators and users of training materials in the world. Much of this material is software used in training and basic skills education, often deployed in interactive settings. There is also a large body of research on learning and teaching effectiveness sponsored by the Federal Government, largely funded by DoD.[43] These resources—computer-based instruction, cognitive retention research, authoring systems for instruction, and many others—are a potential resource for K-12 education.

Technology transfer for training in the Federal Government received a boost with the signing of the Omnibus Trade Act of 1988, a section of which mandated the Department of Education to establish a Training Technology Transfer Office, and to contract with the National Technical Information Service (NTIS) to collect and disseminate such information. NTIS, part of the Department of Commerce, is the agency charged with making available at cost any technical material a Federal agency deems valuable to the public. NTIS works on an entirely cost-reimbursable basis; thus, no Federal funds are appropriated to support this effort. The Training Technology Transfer Act requires each agency to designate an officer of the agency to act as liaison and disseminator to the public of that agency's education and training software. Funds were authorized for development and conversion of exemplary software to the public sector, but no funds have yet been appropriated for this effort.[44]

There are numerous barriers to overcome if the Federal Government is to be an effective technology transfer agent for training. One is creating agency incentives to participate in such activities. The agencies' missions do not include seeking out secondary users for agency products. The Trade Bill legislation, requiring cooperation on this effort from the agencies, may help to create a tradition of transfer, although "forced transfer" has been unsuccessful in the past. Another barrier is the cost of disseminating information on such materials. Writing software descriptions, assembling demonstration discs, and coordinating extensive efforts by agency instructional experts all represent significant time and money commitments, and are not likely to be within the capabilities of an agency public information office. A third barrier is the cost of actually converting training texts and software for another use; such costs are significant, although much less than creating such materials from scratch.

There are potentially significant educational resources produced by the Federal Government that might apply to distance learning curricula and instructional effectiveness. It is difficult to gauge how much of this material would be applicable to K-12 education because so little evaluation or transfer is being done.

GOVERNMENT REGULATION OF TELECOMMUNICATIONS

The regulations guiding telecommunications infrastructure and services have a significant impact on the ways and means by which distance education is made available to the Nation's schools. Many of these policies and regulations are currently being reexamined. The education community will compete with many other stakeholders for influence. The overlapping regulatory authorities and competing interests of well organized groups threaten to submerge the interests of the education community in this debate. At the same time, the opportunity exists for education to influence important policy decisions in telecommunications.

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[41] Larry Quinn, Video and Teleconferencing Division, U.S. Department of Agriculture, personal communication, Mar. 1, 1989.

[42] Isaac Kirk, Office of Information Resources Management, Nuclear Regulatory Commission, personal communication, February 1989.

[43] U.S. Congress, Office of Technology Assessment, *Power On! New Tools for Teaching and Learning*, OTA-SET-379 (Washington, DC: U.S. Government Printing Office, September 1988), ch. 7.

[44] Darcia Bracken, National Technical Information Service, U.S. Department of Commerce, personal communication, Mar. 1, 1989.

The Regulatory Environment for Telecommunications

Telecommunications regulatory authority and policymaking is shared by many in the public sector, including an independent Federal agency, an executive branch agency, Congress, the Federal courts, and State and local authorities. Federal regulation of telecommunications is administered primarily by the Federal Communications Commission (FCC), which coordinates use of the airwaves and provides general oversight of the broadcasting, cable, and telephone industries. In the Department of Commerce, NTIA coordinates executive branch telecommunications policy. The telephone industry is influenced by the decisions of U.S. District Court Judge Harold Greene, who is administering the agreement—the Modification of Final Judgment (MFJ)—that resulted in the breakup of the Bell System. State public utility commissions regulate intrastate and local telephone service, and State and municipal governments oversee local cable franchises.

The fragmentation of telecommunications regulation and policymaking may inhibit development of a coherent plan for educational telecommunications. Furthermore, since the education community is diverse and speaks with many voices, it may be difficult to have its concerns articulated over the din of other stakeholders more fluent in these issues. On the other hand, the volatility of the telecommunications policymaking environment may work to the advantage of education interests. Because the Nation's schools represent a major market for new technology applications, the education community could create a powerful position from which to influence telecommunications policy.

Telecommunications Issues for Education[45]

Government regulation of telecommunications infrastructure and services affects the availability, cost, and types of services schools can use. Availability of telecommunications services to education is controlled in a number of instances by the Federal Government. FCC determines the allocation of the public spectrum, including the number of ITFS channels. In 1983, the FCC removed underused spectrum from ITFS and also allowed licensees to lease ITFS channels to other users, resulting in fewer channels being available for education. FCC also controls the licensing of satellites.

Another critical issue affecting the availability of telecommunications services is the restrictions placed on the Bell Operating Companies (BOCs) as a result of the MFJ. BOCs are currently prohibited from providing inter-exchange (long distance) services, and are greatly restricted in the information services they can provide.[46] Currently, these policies are being revisited by telecommunications policymakers. BOCs claim that these restrictions slow the development of advanced telecommunications services and that educational customers are not able to get the full service applications they want, such as videoconferencing.[47] Opponents argue that there is no guarantee BOCs will provide this service any less expensively or with higher quality than other providers. Opponents also fear the telephone companies may monopolize the content provision market. Educators and State and local education policymakers are divided on these issues, which are currently under review by FCC and Congress.

Federal and State regulations that govern the public telephone network affect distance education costs. State regulators control local telephone rates and telephone company construction; FCC controls long distance rates for dominant carriers (i.e., AT&T) and interstate access charges to local telephone companies. New forms of rate regulation, based on a set price for services rather than a guaranteed rate of return to providers, are being implemented in many jurisdictions. Some expect these changes to lead to lower costs for users, while others worry that locking in prices as technology gets cheaper will actually disadvantage users.

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[45] This section of the report draws heavily on a workshop and subsequent paper produced on behalf of this study. The colloquium, "Changing Telecommunications Technology and Policy Implications for Distance Learning," was held on Feb. 16, 1989, under the auspices of The Annenberg Washington Program of Northwestern University. The resultant paper explores the range of telecommunications policy issues that may affect the provision of successful distance learning. Lynne Gallagher and Dale Hatfield, *Distance Learning: Opportunities in Telecommunications Policy and Technology* (Washington, DC: The Annenberg Washington Program of Northwestern University, May 1989).

[46] The Modification of Final Judgment restrictions on information services, along with the Cable Communications Act of 1984 (concerning video programming), essentially limits the BOCs to providing the pipeline to carry content created by others. The content restrictions were implemented to ensure that the owner of the public information highway, the BOCs, would not also control what content was carried over that highway.

[47] Cathy Slesinger, NYNEX Government Affairs, personal communication, July 24, 1989.

The types of services that could become available to serve education are critical to the future development of distance learning, and will be strongly influenced by Federal telecommunications policies being set today. Narrowband Integrated Services Digital Networks (ISDN) and advanced switching technologies, for example, give users greater capabilities for exchanging voice, data, and some video services. An alternative technology on the horizon is integrated broadband networks, whether telephone or cable. Broadband networks would be capable of carrying full-motion video and would go a significant step beyond narrowband ISDN.

The pace and location of ISDN or broadband deployment will depend on many factors, including pricing and depreciation rates. Faster depreciation could encourage the deployment of new networks at the expense of higher prices for existing services.[48] Some States have allowed local telephone companies to charge slightly higher rates to generate funds to upgrade rural service. Some BOCs have promised to upgrade their systems in rural areas to accommodate the eventual deployment of ISDN in exchange for regulatory flexibilities. Opponents argue that, even in the short term, ordinary ratepayers should not disproportionally bear the costs for upgrading the network. Rural customers, especially, are vulnerable to bearing development costs for services that would not benefit them immediately.

It has been argued that modifying the current restrictions on telephone company provision of video and information services would also speed development of a broadband network. Proponents of the regulations now in place argue that the threat of monopoly posed by the telephone companies controlling content and delivery of video services are great. In the long run, they argue, this may drive cable television companies and other providers out of business, and reduce the choice and diversity available to local communities.[49]

Universal access to information services, perhaps defined as narrowband ISDN capacity, may be an important objective for the distance education community. On the other hand, the education interests may want to advocate jumping directly to a broadband network, capable of carrying full-motion high-quality video in conjunction with other services. Such choices are tied to the broad range of regulatory issues, including the content restrictions on BOCs and what sectors will pay for such a massive infrastructure investment.

Besides determining the conditions under which communications services can be offered and what these services may cost, regulatory agencies are also active in setting standards and protocols that ensure the interoperability necessary for successful communications systems. To date, interoperability has been accomplished with the various transmission technologies used in distance learning systems. Government action can range from ratifying industry-determined or de facto standards to involvement in standards research and decisionmaking.

The philosophies underlying the role of communications in a democratic society inform telecommunications policy debates. If communication is defined as a market commodity, education has enormous economic clout because of the size of the education endeavor. If communication is seen as a springboard for economic growth, education is increasingly perceived as the critical ingredient needed in a global economy. If communication is seen as a basic component of the social infrastructure, education may flourish in its traditional role as the primary tool for creating social and economic equality.[50]

All three of these philosophies, and the subsequent view of Federal involvement in telecommunications policy implied, require thoughtful explication in the education community. The experiences accumulated from the recent surge of distance education efforts can inform this critical discussion.

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[48] Gallagher and Hatfield, op. cit., footnote 45, p. 15.

[49] Ibid., pp. 14-17.

[50] U.S. Congress, Office of Technology Assessment, *Critical Connections: Communication for the Future* (Washington, DC: U.S. Government Printing Office, in press).

Appendixes

Appendix A

Distance Education Activities Across the Nation: A State-by-State Profile

The number of distance learning projects operating or being planned in the United States has grown from only a handful to many. Today, virtually every State is interested in using telecommunications to serve education, actively planning for distance education, already administering a statewide plan or system, or has local distance learning projects in place. Activity in distance education varies. A few States have coordinated plans, while others are just beginning. Some efforts involve only local schools and districts, others also involve various postsecondary institutions such as the State's community colleges and universities, while still others bring in various agencies of the State government such as the Department of Education or the State telecommunications agency. States are also beginning to look beyond their borders to share resources and respond to national programs.

The following State profiles are based on information from surveys conducted by the Council of Chief State School Officers[1] and the California Postsecondary Education Commission.[2] Additional information was provided by the U.S. Department of Education, representatives from various State agencies, local educators and administrators, and private business. Supporting material was also gathered from OTA contractor reports,[3] OTA site visits, and participation in various distance education conferences and workshops around the country.

Because efforts in K-12 distance education are so recent and so varied, the information in this appendix is neither final nor complete. Rather, the following profiles represent a first attempt to outline the range of distance learning projects and plans unfolding across the Nation. Many efforts that now serve only higher education or State government, but could be expanded to include the K-12 community as well. Some local projects could also be expanded to include more sites or to connect clusters of sites. Many States have begun to plan for the future, and this information is included as well.

Alabama

State planning[4]—The Alabama Commission on Higher Education (ACHE), with Alabama Educational Television (AETV), completed a study on State educational telecommunications systems.

Description of State/local efforts[5]**:**

- AETV distributes K-12 supplementary programming over the State's public television stations.
- Alabama is a member of the Satellite Educational Resources Consortium (SERC) Star Schools project; the University of Alabama at Tuscaloosa produces programming for the Texas Interactive Instructional Network (TI-IN) Star Schools project; and the University of Alabama at Birmingham is a member of the Midlands Star Schools Consortium.

Future/planned activities—ACHE is studying activities in other States to guide Alabama distance education policymaking.

Alaska

State institutions involved in planning[6]—Governor's Telecommunications Council, University of Alaska, Alaska Public Broadcasting Commission (APBC), State agencies, courts.

State/local efforts:

- The University of Alaska operates the Alaskan Teleconferencing Network and the University of Alaska Computer Network (UACN). Local school districts use these systems for electronic mail and audioconferencing; some instructional resources are delivered over the networks.
- The State Department of Administration operates the Rural Alaska Television Network (RATNET), a satellite service that delivers some educational programming (both instructional television—ITV—series and live interactive), but is primarily devoted to news and entertainment programming.

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[1] Council of Chief State School Officers, "State Survey on Distance Education Networks," unpublished document, February 1989.

[2] California Post-Secondary Education Commission, "Statewide Projects and Planning Efforts in Educational Telecommunications," unpublished cument, Jan. 17, 1989.

[3] See especially Bruce Barker, Texas Tech University, "Distance Learning Case Studies," OTA contractor report, June 1989; and Richard Hezel, atrix of State Planning, Coordination, and Operations of Distance Learning Technologies," OTA contractor report, June 1989.

[4] State planning refers to statewide planning efforts in distance education, educational telecommunications, and/or other telecommunications systems may serve education.

[5] Except where otherwise noted, descriptions of State and local projects include the transmission of courses for students and/or teacher training and development programs.

[6] Planning that is regional or local, not statewide. Planning that is informal; no State mandate or document exists that establishes central statewide ning authority.

[7] SEA is a generic term used to refer to the State education agency, such as a Department of Education or the Office of Public Instruction.

- The Office of Instructional Services of SEA[7] uses RATNET and UACN to provide K-12 resources and staff development on a limited basis.
- The University of Alaska operates an audiographics project that serves 10 villages. Courses are taught from the hub in Kotzebue, or from campuses at Fairbanks, Anchorage, or Juneau.

Future/planned activities—No new projects are currently planned, although RATNET may be reorganized to provide more education services. APBC hopes to form a consortium with the University of Alaska and SEA to provide instructional radio services to schools.

Arizona

State planning—The Arizona Educational Telecommunications Cooperative (AETC), composed of the three State universities, the community colleges, SEA, and the State Department of Administration (SDA), is conducting an assessment of educational telecommunications needs and available technology resources to be completed in December 1989. SEA completed the "Arizona Telecommunications Survey Report" in 1988; the survey included recommendations for distance education.

Other institutions involved in planning—Board of Regents, public television stations, community colleges, Arizona School Services through Educational Technology (ASSET).

Legislation—The State legislature added $80,000 to the current needs assessment under way.

Current State/local efforts:

- In September 1989, AETC held its first statewide satellite teleconference that reached an estimated 22 sites.
- The University of Arizona has recently been granted 19 Instructional Television Fixed Service (ITFS) licenses.
- Arizona State University uses ITFS and compressed video to reach 17 sites. The University is also one of the partners in the Technical Education Research Centers (TERC) Star Schools project, and serves as 1 of TERC's 10 teacher training centers.
- Some Arizona schools receive programming from TI-IN, while others get programming from Oklahoma State University's Arts and Sciences Teleconferencing Service (ASTS).
- The Peach Springs project involves a K-8 school on the Haualapai Reservation. Each classroom has computers, TV monitors, and telephones, and is connected to a closed circuit cable network with access to satellite programming. Students run the system.
- Maricopa County Community Colleges have a 10-site digital microwave network that links all campuses for audio and data applications; videoconferencing has been tested on the system. A separate audioconferencing system, SunDial at Rio Salado Community College, provides audioconferencing services for the county, reaching remote class sites as well as homebound students.

Future/planned activities:

- SDA is planning the Educational Telecommunications Network, a statewide microwave network that will serve higher education and State agencies. The plan includes local ITFS systems to extend the microwave backbone to deliver K-12 and college credit classes to each community along the microwave route.
- A fiber optic system linking seven community centers (including elementary and secondary schools) and one high school is being built on the Gila River Indian Reservation. The system may also link four high schools outside the reservation and Arizona State University.
- The community of Spriggerville is developing a technology-based learning center linked with the local community college for course sharing, training, and videoconferencing.

Arkansas

State planning—A State plan developed by the Governor's Task Force on Telecommunications in 1985. Instructional Microcomputer Project for Arkansas Classrooms (IMPAC), a nonprofit corporation, is responsible for technology dissemination in K-12 classrooms, including distance education technologies. Arkansas Educational Television Network (AETN) Commission oversees educational/public television programming.

Other institutions involved in planning—SEA, State universities.

Legislation—Established guidelines for satellite-delivered distance education and use of educational technology.

Current State/local efforts:

- Twenty-seven schools have received satellite programming and K-12 courses from Oklahoma State University's ASTS, Utah Office of Education, and TI-IN. Schools pay all costs except for maintenance of equipment, which is provided by IMPAC.
- The Malvern High School Communications Link connects two local high schools and Henderson State University via computer, two-way television, and radio.

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[7] SEA is a generic term used to refer to the State education agency, such as a Department of Education or the Office of Public Instruction.

- The State is a participant in the SERC Star Schools project.

Future/planned activities:

- IMPAC has purchased an uplink, and plans to provide staff development programs.

California

State planning—Educational Technology Committee, California Postsecondary Education Commission (CPEC).

Other institutions involved in planning—SEA, Governor's Office, legislature, University of California system, the California State University (CSU) system.

Legislation—Legislation to establish funding for distance education has been introduced. In September 1989, legislation created a Commission for Educational Technology and charged the Commission with developing a statewide plan for educational technology, including telecommunications.

Description of State/local efforts:

- CSU-Chico transmits staff development courses to 16 sites via an ITFS/microwave network, and has a satellite uplink to deliver programming to these and other California sites. Chico also produces programming for the TI-IN Star Schools project.
- CSU-Stanislaus uses ITFS to transmit courses from three originating sites to eight sites in five central California counties. A courier system is used to transport course materials.
- Fifteen of nineteen CSU campuses operate or have access to ITFS systems, and many provide inservice staff development. All CSU campuses are connected via CSUNET, a computer telecommunications network.
- The Los Angeles County Office of Education operates the Educational Telecommunications Network (ETN). ETN transmits staff development courses to 55 sites in California via satellite.
- The Los Angeles Unified School District (LAUSD) operates a "homework hotline" in conjunction with live broadcasts from KLCS Channel 58, a PBS station owned and operated by LAUSD. Students phone in questions in a variety of subject areas, and the questions are answered either by telephone tutors or by a teacher on television.
- California Polytechnic State University in Pomona uses satellite and ITFS to deliver college credit courses to 18 high schools in 3 counties. Students attend the live classes before school, and use WATS lines to call in questions during the class. Materials are delivered by courier.
- Pepperdine University is 1 of 10 teacher training centers for the TERC Star Schools project.
- Fifteen schools receive programming from the TI-IN Star Schools project.
- Some schools in the State also receive programming from Oklahoma State University's ASTS.

Future/planned activities:

- Current planning efforts may lead to the development of a statewide telecommunications network. Education agencies and institutions may participate in such a network or may develop their own dedicated network.
- The San Francisco School District has joined a consortium with the Chicago, Dallas, New York City, and Philadelphia school districts to develop a satellite network for urban schools.

Colorado

State planning—The Colorado State Telecommunications Advisory Commission, made up of representatives from K-12, higher education, industry, and public television, is conducting an assessment of educational telecommunications resources and needs. Survey results and recommendations will be presented in December 1989. The University of Northern Colorado Educational Technology Steering Committee has prepared a report, the "University of Northern Colorado Statewide Telecommunications System."

Other institutions involved in planning—SEA, Department of Administration, local Boards of Cooperative Services (BOCS), universities, community colleges, public television stations, State legislature, US West.

Current State/local efforts:

- Boulder Valley Distance Learning Project uses audiographics to offer Advanced Placement courses taught at one urban high school to seniors in a remote mountain high school.
- Intermountain Community Learning and Instructional Services, based at Utah State University, uses audiographics to deliver instruction to high school students and teachers in four schools in each of Montana, Wyoming, Utah, and Colorado.
- Morgan Community College uses audiographics to teach astronomy to high school students.
- An interactive television network using local cable television facilities connects Poudre, Fort Collins, and Rocky Mountain high schools with their District Media Center.
- Four campuses of the Colorado University System are connected via fiber optics for telephone and data communications.
- Biological Science Curriculum Study in Denver is 1 of 10 TERC Star Schools teacher training centers.
- Some schools in the State also receive programming from TI-IN and Oklahoma State University's ASTS, and some participate in the TERC Star Schools project.

Future/planned activities:

- Jefferson County plans to link three high schools to share courses, deliver inservice training to teachers, and hold teleconferences.
- Several local BOCS are involved in planning: the South West BOCS is conducting a needs assessment, and plans to link seven districts and local institutions of higher education in an interactive audio/video network that will provide high school courses and staff development programming. San Luis BOCS plans a digital microwave system that will link local schools for course sharing and may also reach out to local businesses and social service agencies.
- The Western Cooperative for Educational Telecommunications, based in Colorado, with institutional members in 15 States, will help plan K-12 and higher education distance learning activities. The cooperative will provide information on available resources, aid in developing staff training and inservice programming, help identify funding sources, and facilitate cooperation among schools and States.
- The University of Northern Colorado plans a statewide telecommunications system that will link 13 sites in the State with compressed video for college and K-12 teacher courses and teleconferences. Three sites will be completed by the end of 1989, with all sites connected by 1991.

Connecticut

State planning—The Joint Committee on Educational Technology, a standing committee of the Board of Education and the Board of Governors for Higher Education, coordinates educational telecommunications and is responsible for long-range planning and development of educational technologies for all levels of education. In 1989, the Board of Education released a report prepared by SEA, "A Guide to Learning Resources and Technology," that included a section on distance learning.

Other institutions involved in planning—Southern New England Telephone (SNET), Department of Community Colleges, universities.

Legislation—Legislation established the Joint Committee on Educational Technology in 1982. Subsequent legislation created the Telecommunications Incentive Grant Program in 1986. Legislation requires cable companies to provide an educational access channel.

Current State/local efforts:

- SEA administers the Telecommunications Incentive Grant Program to seed local distance learning projects for up to 3 years. Grants total $85,000 per year, shared among eight or nine applicants.
- Links to Learning is a joint project between SEA and SNET. Approximately 30 schools use voice messaging, computer database access, or compressed video in a variety of applications. Ten additional schools are expected to join the project next year.
- Area Cooperative Educational Services in Hamden coordinates a fully interactive fiber optic system linking five schools. Fourteen courses will be offered during 1989-90.
- Talcott Mountain Science Center transmits science enrichment programming via satellite to over 300 schools in 35 States. Audio interaction is possible

Future/planned activities:

- SEA is building a two-channel ITFS system that will reach most schools and colleges in the State by 1992.
- StateNet is being built for the Office of Planning and Management, and will serve all State agencies, including education, with voice and data services.

Delaware

State planning—SEA, Office of Information Systems. No State plan or documents.

Other institutions involved in planning—State agencies, colleges.

Current State/local efforts:

- Project Direct is a statewide K-12 electronic network that is used primarily for administration.
- Ten high schools have satellite dishes.

Florida

State planning—SEA.

Other institutions involved in planning—Universities, community colleges.

Legislation—Legislation endorses the use of computers, educational television, and radio for the improvement of education in the State.

Current State/local efforts:

- SEA runs Florida Information Resources Network, a data communications network used for computer conferencing, database access, and support of computer-based courses in K-12 and higher education. The system connects all of the State's K-12 districts, 25 of 28 community colleges, and all public universities.
- The State Satellite Network, operated by SEA in conjunction with the Department of General Services, links 28 sites. While education is given priority, the system can be used by anyone in the State.
- Florida has extensive ITFS facilities. The Marion County Instructional Television Program, for example, uses ITFS to link 5 high schools, 1 community college, and 29 elementary and middle schools.
- The State is a member of the SERC Star Schools project; 12 schools in the State receive SERC programming.

Georgia

State institutions involved in planning—SEA, Georgia Public Telecommunications Commission, colleges and universities.

Current State/local efforts:

- The Georgia Public Telecommunications Commission in cooperation with SEA, operates an educational television network that supplies instructional video materials to K-12 and higher education. The commission may extend the reach of programming via microwave.
- The State is a member of the SERC Star Schools project.

Hawaii

State planning—"The Distance Learning–Technology Plan" was prepared in August 1988 by SEA, the Department of Labor and Industrial Relations, and the University of Hawaii. It details a framework for using all types of telecommunications for education. The plan also established an Educational Technology branch within SEA. The Superintendent's Office is working to obtain a cable access channel dedicated to education.

Other institutions involved in planning—Universities and community colleges.

Legislation—Preparation of a plan for distance learning was authorized by the legislature in 1987; subsequent legislatures have authorized $590,000 through 1989 for implementation.

Current State/local efforts:

- TELEclass Project links students in Hawaii and those in Japan and Australia with voice and video exchanges.

Future/planned activities:

- Interactive statewide networks will use a combination of ITFS, cable television access, fiber optics, and microwave for video distribution and voice/computer links for audio and computer conferencing.

Idaho

State planning—SEA; the Telecommunications Council, comprised of SEA, the Board of Regents, and the Idaho Educational Public Broadcasting System (IEPBS), coordinates telecommunications delivery of education services.

Other institutions involved in planning—Board of Higher Education.

Current State/local efforts:

- The Idaho Rural Education Delivery System, operated by SEA in cooperation with Boise State University's Simplot/Micron Center, Boise School District, and IEPBS, involves five rural high schools and consists of live video broadcast by IEPBS with two-way audio interaction.
- Both Boise State and the College of Southern Idaho operate ITFS systems.

Illinois

State planning—The Governor's Task Force; the "Strategic Communications Network Plan" outlines options for a statewide telecommunication system to serve State agencies; some capacity allocated to higher education.

Other institutions involved in planning—Northern Illinois Learning Resources Cooperative, universities and colleges, implementation task forces for State plan.

Current State/local efforts:

- K-12 electronic network links SEA with 18 regional education centers.
- The North Central Regional Educational Laboratory produces staff development telecourses distributed via satellite by PBS.
- Several institutions of higher education, including Triton College and Waubonsee Community College, have ITFS systems. Waubonsee also operates an interactive microwave system that links the community college to a downtown college and four local high schools.
- SEA is a partner in the TI-IN Star Schools project. Western Illinois University provides mathematics and science programming for TI-IN, and 52 schools in the State have received equipment and courses under the TI-IN Star Schools project.
- Some schools in the State also receive programming from Oklahoma State University's ASTS.

Future/planned activities:

- The Strategic Communications Network Plan calls for a fiber optic backbone system to carry voice, data, and eventually video traffic for various applications including distance learning.
- Illinois Central College is planning a system that would link the college to eight local high school districts.
- The Chicago School District has joined with the Dallas, New York City, Philadelphia, and San Francisco school districts to develop a satellite network for linking urban schools.

Indiana

State planning—Indiana Higher Education Telecommunications Services (IHETS). Intellenet is a statewide fiber optic/microwave network that provides telecommunications services to State agencies as well as education.

Other institutions involved in planning—State agencies (Intellenet), SEA.

Legislation—IHETS created in 1967.

Current State/local efforts:

- IHETS statewide fiber optic backbone (leased from Intellenet) delivers three channels of one-way video, two-way audio interactive university courses to both secondary and postsecondary students in 14 sites served directly by fiber. Twenty-five local ITFS systems (four channels) extend the programming on the fiber system to over 200 additional sites.
- Some schools in the State receive programming from Oklahoma State University's ASTS.

Future/planned activities:

- IHETS is considering expanding K-12 programming.

Iowa

State planning—Iowa Public Television; the Narrowcast Advisory Committee acts as a statewide educational telecommunications coordinating body with representation from Iowa community colleges, SEA, and the Board of Regents.

Other institutions involved in planning—Department of Economic Development, legislature, higher education.

Legislation—Legislation in 1986 authorized development of a statewide educational telecommunications plan that was completed in 1987. The legislature voted $50 million to fund the plan.

Current State/local efforts:

- The Fiber Optic Communication Instruction System is an interactive television network connecting five local high schools to a magnet school campus in Des Moines.
- The Kirkwood Community College Telecommunications System uses a combination of satellite, ITFS, microwave, and cable to serve 14 high schools in 7 districts.
- Iowa is a member of SERC, but did not participate in the Star Schools grant awarded to SERC.

Future/planned activities:

- The State is planning to build a statewide telecommunications network to serve all levels of education. The system will use a combination of fiber optics, microwave, and ITFS to deliver educational programming and voice, data, and video services.

Kansas

State institutions involved in planning—Board of Regents, Division of Information Systems, colleges and universities.

Current State/local efforts:

- University of Kansas and Kansas State University produce programming for the Midlands Consortium Star Schools Project, and several sites in the State will receive programming.
- Some schools in the State also receive programming from Oklahoma State University's ASTS.

Kentucky

State planning—Kentucky Educational Television (KET).

Other institutions involved in planning—SEA, Council on Higher Education.

Legislation—In 1987, the Kentucky General Assembly voted $11.4 million to construct the Star Channels system. A proposal has been written to create the Kentucky Educational Networking System to link all school districts, schools, and SEA for administrative and instructional support purposes.

Current State/local efforts:

- The KET Star Channels system, a statewide educational satellite network is being constructed, and will include a central transmitting site serving downlinks at each of the State's 1,300 elementary and secondary schools. The system will carry live interactive (audio and data) student courses, enrichment, and staff development programming.
- The Tennessee Valley Authority supports a distance learning project that connects three local districts in Hickman and Fulton counties with fiber. Paducah Community College and Murray State University are linked by microwave, and are trying to link to local districts.
- Kentucky is a member and a course producer in the SERC Star Schools project. Twenty-four schools across the State receive SERC programming.

Louisiana

State planning—Office of Telecommunications Management.

Other institutions involved in planning—Louisiana Educational Television Authority, Louisiana State University.

Current State/local efforts:

- The Louisiana Educational Satellite Network (LESN) broadcasts interactive video programming to 16 pilot sites in the State. LESN operates out of Southern University, Shreveport, and offers many programs in collaboration with the National Aeronautics and Space Administration Regional Teacher Resource Center.
- Two parochial schools, Breaux Bridge and St. Martinville, are connected to a local public school via fiber optics, allowing the parochial school students access to the public school's Integrated Learning System.
- Louisiana is a member of SERC and a Star Schools participant.

Maine

The State planning—The University of Maine at Augusta prepared the Plan for a Community College of Maine/Telecommunications System, and coordinates operation of the system.

Other institutions involved in planning—University of Maine System, SEA, Maine Public Broadcasting Network, Maine Technical College System.

Legislation—The legislature appropriated $2.2 million for the Community College of Maine/Telecommunications System.

Current State/local efforts:

- The Community College of Maine/Telecommunications System uses a combination of fiber optics, ITFS, and satellite to deliver courses and programming. The seven campuses of the University of Maine System are connected by fiber optics, while the Technical Colleges, the Maine Maritime Academy, and 12 off-campus university centers receive programming via ITFS. Eventually, these sites will be connected to the fiber optic backbone. Twenty high schools also receive programming via ITFS, and eventually all high schools will be connected when the system is completed in 1993.
- Some schools in the State also receive programming from Oklahoma State University's ASTS.

Future/planned activities:

- Universities in Maine, New Hampshire, and Vermont are working with New England Telephone to create a Northern Tier Network that would use fiber optics and satellite capabilities to allow the States to share programming.

Maryland

State planning—SEA/Division of Instructional Technology has a "Strategic Plan for Educational Technology" that includes goals for distance education. A 2-year "Action Plan" guides the design and development of interactive television networks around the State; SEA is developing a new 5-year strategic plan that will extend present planning.

Other institutions involved in planning—Maryland Public Television.

Current State/local efforts:

- In addition to the State plan, some counties and districts have begun their own systems:
  - — Anne Arundel County links 12 high schools using local cable television facilities. The fully interactive system allows two-way audio and video communication.
  - — The Prince George's County Interactive Television Network uses interactive cable television facilities to connect six high schools, a community college, and the district's media center. The two-way system delivers instruction during school hours, after school, and on the weekends.
  - — Carroll, Washington, and Montgomery Counties use cable systems to connect some of their high schools for course sharing.
  - — Baltimore County has linked two schools with cable and plans to connect four more in 1990.
- SEA offers K-12 instructional television and staff development programming over public television, and Maryland Public Television in conjunction with the College of the Air offers college-level courses.
- The University of Maryland offers advanced graduate courses (leading to a Master's Degree) and some undergraduate courses to business and industry over its ITFS system. The University also produces satellite-delivered courses for the National Technological University.

Future/planned activities:

- SEA plans to create and ultimately connect local two-way interactive television networks. School clusters will also be able to receive satellite programming.
- Seventeen community and junior colleges are planning a compressed video network that will allow them to share courses and coordinate administrative activities.
- The Maryland Higher Education Commission has proposed a satellite system that would deliver programming to higher education institutions all over the State.

Massachusetts

State planning—Massachusetts Corporation for Educational Telecommunications (MCET).

Other institutions involved in planning—SEA, colleges and universities.

Legislation—MCET was formed by legislation in 1982.

Current State/local efforts:

- The Cambridge Teleteaching Group uses audiographics to deliver courses to local high schools. The project was funded by Annenberg/Corporation for Public Broadcasting, AT&T, and MCET.
- Kids Interactive Telecommunications Project by Satellite is a satellite-based system operated by the University of Lowell, which allows two-way video and computer conferencing between three schools in the State and a school in West Germany. The University also serves as the coordinator of a network that uses interactive cable television and microwave to link eight local districts.
- South Berkshire Educational Collaborative uses a two-way interactive cable television system to link four schools.

- TERC, a federally funded Star Schools project, is based in Cambridge, and many schools in the State participate in the TERC project. The Boston Museum of Science and Tufts University are 2 of TERC's 10 teacher training centers.

Michigan

State planning—Department of Education, Governor's Telecommunication Task Force. The State Board of Education prepared an "Inventory of Instructional Telecommunications Systems in Michigan" in March 1989.

Other institutions involved in planning—Michigan Community College Association, Public Service Commission.

Current State/local efforts:

- Michigan Statewide Telecommunications Access to Resources (M*STAR) provides instructional television programming to all K-12 schools, intermediate school districts, and regional educational media centers.
- The Merit Computer Network links Michigan's universities in a statewide network. The University of Michigan manages the system.
- Providing Academics Cost Effectively (PACE) is an interactive television project linking 4 intermediate school districts, 39 local districts, 2 community colleges, and 1 university. The system uses a combination of cable television and microwave facilities to provide courses to participating schools.
- Many projects use cable television and microwave facilities to deliver interactive television courses to local districts:

— Dearborn Public Schools Cable Utilization Project links six schools;

— in the Oakland Intermediate School District Telecommunications Project, 75 schools use the system to transmit data, and plans call for a 14-channel audio, video, and data system linking 28 districts;

— eight high schools are linked to Kirtland Community College;

— the Saginaw County Interactive Television for Schools system links 13 school districts with 2 institutions of higher education;

— the Shores Interactive Video Project links three high schools and the local public library;

— two high schools are connected in the Walled Lake Schools Telecommunications System; and

— the Two-way Interactive Delivery System for Schools uses two-way cable, microwave, and fiber optics to link 12 school districts and the local community college. Plans call for linking additional schools and Michigan State University.

- The Archdiocese of Detroit operates a four-channel ITFS network reaching over 300 Catholic parishes. The system also connects with local cable companies to provide instructional programming to K-12 students in southeastern Michigan.
- Eight Detroit high schools use ITFS for local programming and to bring in M*STAR programming.
- The University of Michigan is 1 of TERC's Star Schools partners and serves as 1 of the 10 regional teacher training centers.
- Detroit is one of the four associate members of SERC.

Future/planned activities:

- The Michigan Community College Telecommunications Network, under construction, will place satellite dishes at each of the State's 29 community colleges, allowing the colleges to deliver interactive educational services to students, local businesses, and community groups.
- The Upper Peninsula-Wide Telecommunications Network will use microwave to reach 33 schools and 4 postsecondary institutions in the remote upper peninsula of the State.
- The Michigan Information Technology Network is a satellite delivery system being developed to provide advanced engineering courses to business and industry in the State. The system will involve four universities, all community colleges, and local businesses.

Minnesota

State planning—State Planning Agency, State Telecommunications Access and Routing System (STARS) Advisory Council, SEA, Department of Administration Information Policy Office.

Other institutions involved in planning—Minnesota State University System, State Board of Vocational and Technical Education, Minnesota Coordinating Board for Higher Education.

Legislation—In January 1988, a Task Force on Instructional Technology was created to study instructional uses of telecommunications. The Task Force's "Report to the Minnesota Legislature" (December 1988), included recommendations for funding educational telecommunications systems. The legislature has authorized STARS, a statewide telecommunications system. The State Senate has placed a moratorium until 1990 on spending for new higher education distance learning projects in the State.

Current State/local efforts: One-third of the State's school districts have some form of interactive distance learning capabilities. Some of these include:

— the Des Moines River Tele-Media project linking 12 school districts with fiber optics;

— the East Central Minnesota Educational Cable Cooperative (ECMECC) using two-way cable tele-

vision and microwave to link seven districts;
  - five local school districts, Mankato State University and Technical Institute, South Central Education Service Center, Region 5 Computer Service Unit, and Regional Interlibrary Exchange are linked in the Knowledge Interactive Distribution System (KIDS). KIDS uses microwave, computers, teleconferencing, and ITFS to bring courses to the schools;
  - the Mid-State Educational Telecommunications Cooperative links seven districts in a fully interactive fiber optic system;
  - the Minnesota Valley Tele-Network uses microwave and local public television stations to link nine districts;
  - the Northwestern Minnesota Fiber Optics Project links the University of Minnesota at Crookston, two technical institutes, and nine local school systems;
  - eight districts in the Sherburne-Wright Educational Technology Cooperative are linked via cable and microwave. The cooperative also uses satellite-delivered material and is a member of Classroom Earth, a national educational satellite users organization;
  - in the Sibley County Cooperative Interactive Television project, four districts are connected by two-way cable, computers, and facsimile;
  - 10 school districts in the Southwest Minnesota Telecommunications project are linked by microwave; and
  - the Wasioja Education Technology Cooperative uses fiber optics to link five schools, their central district offices, and between the central offices.
- Schools in the State participate in TERC and some schools receive programming from TI-IN; and
- Minnesota Educational Computing Consortium is 1 of 10 TERC Star Schools teacher training centers.

Future/planned activities:

- STARS is a statewide broadband information network that will serve primarily higher education and business. K-12 schools will gain access through local higher education institutions.

Mississippi

State planning—The Central Data Processing Authority coordinates all telecommunications resources in the State, and is planning a statewide telecommunications network to serve government agencies, especially education. SEA is doing educational planning.

Other institutions involved in planning—Mississippi Authority for Educational Television.

Current State/local efforts:

- The Mississippi Authority for Educational Television operates a statewide network that delivers instructional video materials.
- Some schools in the State receive programming from Oklahoma State University's ASTS,
- As a member of the SERC Star Schools project, 11 schools have downlinks and receive programming.
- The University of Mississippi is a member of the Midlands Consortium. Sixty-five schools will receive satellite downlinks from Midlands.
- Mississippi State University at Starksville produced inservice training programs in mathematics and science for the TI-IN Star Schools Network. Thirty-one schools have received downlinks from TI-IN.

Future/planned activities:

- Fifty-six school districts, SEA, and Apple Computer are cooperating in a pilot project using electronic mail.

Missouri

State planning—Missouri Education Satellite Network (MESN), an organization of the Missouri School Boards Association (MSBA), coordinates educational telecommunications in the State.

Other institutions involved in planning—SEA, Coordinating Board for Higher Education, Chamber of Commerce, State agencies.

Legislation—A tax on videotape rentals for 5 years. Revenue will fund distance learning projects in the State.

Current State/local efforts:

- MESN is a satellite delivery network; 70 sites now participate. MESN produces staff development programming for the Midlands Consortium Star Schools Project, and also brokers K-12 courses and staff development programming from Oklahoma State University, Kansas State University, and STEP (see Washington).
- Kansas City is one of the four associate members of SERC.
- MSBA is a member of the Midlands Consortium Star Schools project.

Montana

State planning—Montana Telecommunications Cooperative.

Other institutions involved in planning—SEA, Commissioner of Higher Education; Department of Administration; State Board of Education.

Legislation—In 1987, a Task Force, comprised of K-12, higher education, and business representives, was created to consider development of a statewide telecommunications network. After an assessment of educational needs and available resources, the legislature appropriated $200,000 in 1989 for a technical plan.

An additional $300,000 was appropriated for expansion of existing educational telecommunications facilities.

Current State/local efforts:

- The Big Sky Telegraph network serves 114 schools in Montana with a computer network providing both K-12 courses and teacher training. The West Educational Support Team (National Diffusion Network State facilitators) uses Big Sky to link education leaders in the 15 Western States (and soon the Trust Territories of the Pacific). The group has received a grant to add 5 rural districts in each of the 15 States to the network.
- Edunet is a private nonprofit company that produces courses and provides computer networking services such as electronic mail to schools in Montana, Idaho, Oregon, and Wyoming.
- Some 75 school districts, 2 community colleges, a tribal school, Montana State University, the University of Montana, and Western Montana University use satellite dishes to receive programming from around the country.
- Approximately 300 sites receive computer-based instructional materials through Big Sky, Edunet, and Goliath, the State network for science and mathematics teachers.
- The Intermountain Community Learning and Instructional Services project, operating out of Utah State University, uses audiographics to deliver instruction to high school students and teachers in four schools in each of Montana, Wyoming, Utah, and Colorado.
- Some schools in the State receive programming from TI-IN.

Future/planned activities:

- A satellite uplink is being built at the University of Montana at Missoula for distribution of high school courses and industry training.

Nebraska

State planning—Nebraska Educational Telecommunications Commission.

Other institutions involved in planning—University of Nebraska, SEA, Governor's Office.

Legislation—Legislation authorized funds for the Nebraska Educational Telecommunications Commission and development of a statewide telecommunications network.

Current State/local efforts:

- Nebraska is a member of the SERC Star Schools project, and Nebraska Educational Television produces programming for SERC.
- The University of Nebraska has an ITFS system, which that will be expanded to include secondary and postsecondary courses.

Nevada

State planning—Office for Telecommunications.

Other institutions involved in planning—University of Nevada, SEA.

Current State/local efforts:

- Some schools in the State receive programming from TI-IN.

New Hampshire

State planning—No formal statewide planning.

Other institutions involved in planning—University System of New Hampshire.

Current State/local efforts:

- Keene Junior High School Project uses microwave to link with five local high schools and a vocational center.
- Manchester School District Instructional Television Network links three schools with fiber optics, allowing the schools to share two-way interactive video/audio courses.

Future/planned activities:

- Universities in New Hampshire, Maine, and Vermont, are working with New England Telephone to create a Northern Tier Network that would use fiber optics and satellite capabilities to allow the States to share programming.

New Jersey

State planning—The Office of Telecommunications and Information Systems (OTIS) coordinates statewide telecommunications resources. SEA's "Educational Technology in New Jersey: A Plan for Action" (May 1986) does not specifically address distance learning, but guides educational technology applications.

Other institutions involved in planning—SEA, Department of Higher Education, State agencies, Office of Management and Budget.

Current State/local efforts:

- The Educational Technology Network is a computer network serving more than 350 districts in the State. It is used for administrative and some instructional purposes.
- The Millford and North Valley school districts are operating a pilot project that links the two districts via cable television.
- St. Peters College provides staff development programming to 10 school districts via satellite.
- The Union Township district has a downlink and an ITFS system to deliver teacher training produced by the New Jersey Institute of Technology and to offer

educational programming such as the Discovery Channel to an estimated 15 districts in the New York City metropolitan area.

- The State is a member of SERC and a participant in the Star Schools project. In the State, 25 districts receive SERC programming, and the State plans to install 15 to 20 additional downlinks by 1990.
- Some schools in the State also receive programming from Oklahoma State University's ASTS.

Future/planned activities:

- Bergen County is planning a county-wide fiber optic system that will connect 46 high schools and 2 community colleges. Sixteen schools are expected to be connected by September 1990, with the remaining schools connected within 5 years. Teacher inservice programming, adult education, and college courses will eventually be offered over the system.

New Mexico

State planning—In 1986, the Instructional Television (ITV) Group, consisting of representatives from education, business, and the military, began a needs assessment for instructional television throughout the State. The group's report, "An Instructional Television Network for New Mexico," released in November 1988, outlines plans for a statewide ITV network.

Other institutions involved in planning—SEA, Higher Education Commission, University of New Mexico, universities and colleges, US West.

Legislation—Legislation in 1987 requested the ITV Group to conduct an assessment of educational telecommunications needs and produce a plan for instructional television. Subsequent legislation that created the State's ITV network also authorized and appropriated $100,000 in annual funding for K-12 distance education to be distributed through SEA.

Current State/local efforts:

- A statewide data communications network connects 15 school districts and several institutions of higher education. The system will eventually serve all public education institutions in the State.
- A fiber optic network connects the Los Alamos National Laboratory, the State Capitol Building, the University of New Mexico, Sandia National Laboratory, the New Mexico Institute of Mining and Technology, and New Mexico State University at Las Cruces for voice, data, and video transfer. College courses are being shared; K-12 courses will begin in January 1990.
- The State's three public television stations maintain a microwave network.
- Three of the University of New Mexico's campuses have ITFS systems. Eastern New Mexico University, for example, has an 8-channel system that is used to broadcast 50 to 60 college credit courses per year. The university also does K-12 programming reaching 35 school districts.
- Schools in the State receive programming from TI-IN.

Future/planned activities:

- A statewide instructional television (one-way video, two-way audio) network is being constructed to serve business and education. The network will incorporate the fiber optic network linking the State universities, the Capitol, and the two national laboratories, and will reach at least 40 sites when it is completed in 1991. The system is expected to cover 85 percent of the State.
- Luna Vocational Technical Institute will offer courses to five local school districts via ITFS beginning in January 1990.

New York

State planning—In 1988, SEA completed a "Profile of Operating Distance Learning Projects in New York State." The New York State Legislative Commission on Science and Technology completed a report, "Distance Learning: The Sky's the Limit," in September 1988. A Board of Regents Task Force is studying educational technology applications including distance learning. The Governor's Task Force on Telecommunications is considering a statewide data network that could be used by education.

Other institutions involved in planning—State University System, Bureau of Cooperative Educational Services (BOCES).

Current State/local efforts:

- The State University of New York (SUNY) Satellite System (SUNYSAT) is piloting adult and continuing education programming to the 64 SUNY campuses. The system also serves as the hub for public television delivery of instructional programming.
- Technology Network Ties is a statewide K-12 computing network that connects local districts, regional computing centers, libraries, and SEA. The network serves administrators, but also has electronic mail and some instructional applications.
- There are more than 100 local distance learning projects operating in New York, primarily in K-12 and rural settings. Some projects include:
  - — Delaware-Chenango BOCES uses audiographics to link 10 schools;
  - — Erie 1 BOCES operates an audiographics system that links six districts, Houghton College, and the Cattaraugus-Allegany BOCES;
  - — in the School/College Key Program, Rochester Institute of Technology, the Livingston-Steuben-Wyoming BOCES, and three districts are linked via audiographics;

- — the Interactive Television Cable Project uses two-way cable to link eight schools in two districts in Pleasantville;
  - — the Islip Union Free School District 2 Computer Conferencing project links students from the district through a host computer operated by New York Institute of Technology;
  - — the Rensselaer-Columbia-Greene BOCES uses microwave and computer conferencing to link five districts and two community colleges with voice and computer conferencing for foreign language instruction. Private industry is also involved;
  - — the St. Lawrence-Lewis BOCES Interactive Telecommunications Network links 19 schools in 3 districts via ITFS and microwave;
  - — the Steuben-Allegany BOCES Long Distance Teaching project links nine school districts with ITFS and computers for course sharing. UHF radio connects schools to a central teaching studio;
  - — Teaching Via Television links Brocton Central High School via cable to SUNY-Fredonia for live interactive audio/video high school courses;
  - — Community School District #24 in Queens uses audiographics to teach homebound students;
  - — five districts and the Rensselaer-Columbia-Greene BOCES are linked by microwave and computers in the Telecommunications Network for Instructional Programs and Administrative Data Processing;
  - — the Video Interactive Teaching and Learning project connects six school districts and Fulton Montgomery Community College. The one-way video, two-way audio cable/microwave system is used to bring K-6 health education to the local districts; and
  - — four schools on Long Island are connected by fiber optics, allowing them to share interactive audio/video classes and data communication. Plans include adding seven new sites.
- Some schools in the State receive programming from Oklahoma State University's ASTS.
- City College of New York is 1of the 10 TERC Star Schools teacher training centers.
- New York City is an associate member of SERC.
- Some schools receive programming from TI-IN.

Future/planned activities:

- New York City Public Schools have joined with the Dallas, Philadelphia, San Francisco, and Chicago school districts to develop a satellite network for linking urban schools.

North Carolina

State planning—SEA.

Legislation—The Agency for Public Telecommunications was created to serve the video and distance learning needs of State agencies.

Current State/local efforts:

- The Distance Learning by Satellite system delivers instruction and inservice training to 146 sites in each of the State's 100 counties.
- In the Downeast Instructional Telecommunications Network, East Carolina University uses audiographics to teach students in six rural schools.
- All 58 of the State's community colleges are linked in a microwave network.
- Five of the State's 16 public universities provide courses over a microwave network. Some institutions, including the North Carolina Microelectronics Center and North Carolina State University, operate ITFS systems.
- The State is a member of the TI-IN and SERC Star Schools projects. The State produces programming for TI-IN, and most of the 146 receive sites in the State receive TI-IN programming.

Future/planned activities:

- SEA is implementing a statewide electronic network that eventually will link all the State's schools.

North Dakota

State planning—An Educational Telecommunications Council (ETC), including representatives from higher education, K-12, public television, and business, has been established to coordinate broadcast, voice, and data services.

Other institutions involved in planning—Prairie Public Television, SEA, Higher Education Telecommunications Advisory Committee, Board of Higher Education.

Legislation—Established the Educational Telecommunications Council.

Current State/local efforts:

- As part of a U.S. Department of Agriculture grant to provide rural health courses to remote hospitals and university campuses, a pilot project has been initiated that connects the University of North Dakota (UND), North Dakota State University (NDSU), Jamestown State Hospital, and the Carrington Extension Research Center of NDSU via fiber optics.
- The communities of Hazen, Beulah, Stanton, and Center are linked via fiber optics. Eventually, the schools would like to bring in inservice and staff development courses over a proposed State backbone network.
- The Decisions About Technology system uses audiographics to link seven districts. Courses originating in Bismarck go to the six rural districts.
- The Red River Valley Telecommunications Consortium consists of 10 school districts and Mayville State University. Sites receive satellite programming from national instructional providers such as Oklahoma State University's ASTS.

- The Riverdale school district is connected by audiographics to Mansfield University in Pennsylvania.
- North Dakota is a member of SERC Star Schools project.
- Some schools in the State receive programming from TI-IN.

Future/planned activities:

- ETC, the Higher Education Telecommunications Advisory Committee, and the participants in the UND pilot project have begun planning a statewide telecommunications backbone. The goal is to connect 10 sites (mostly higher education institutions) by 1990. Eventually all higher education institutions and local districts will be connected.
- The Souris River Project will link schools in Sawyer, Velva, Karlsrueh, and Towner with fiber optics.

Ohio

State planning—SEA. A Task Force on the Classroom of the Future has established an Educational Technology Advisory Commission to study delivery systems for educational telecommunications.

Other institutions involved in planning—Ohio Educational Broadcasting Network; Board of Regents.

Current State/local efforts:

- The Ohio Education Computer Network is being implemented to link K-12 school districts for administrative purposes.
- The State is a member of SERC.
- Some schools in the State also receive programming from Oklahoma State University's ASTS.

Oklahoma

State planning—The State Regents for Higher Education completed a "Report on Development of an Educational Telecommunications Network," which recommended expanding existing higher education telecommunications facilities.

Other institutions involved in planning—SEA, Oklahoma State University (OSU).

Current State/local efforts:

- Oklahoma State University's ASTS delivers high school and staff development courses to 250 schools in 20 States. At least 200 Oklahoma schools receive these interactive courses. OSU is also the home of the Midlands Consortium Star Schools Project, and the Oklahoma SEA serves on the Midlands Board of Directors.
- The Panhandle Shar-Ed Video Network is a digital fiber optic system, built in cooperation with the local telephone cooperative, that links four schools.
- The Regents Network delivers programming throughout the State via microwave and cable.

Oregon

State planning—A statewide telecommunications network was outlined in "Oregon Ed-Net: A Report on the Feasibility of a Statewide Telecommunications Network" (July 1988). The Ed-Net Planning Committee represents K-12, community colleges and higher education, various State agencies, public television, and the private sector. The State Board of Education sets State policy for distance education.

Other institutions involved in planning—SEA, K-12 Educational Technology Advisory Committee, universities, Oregon Public Broadcasting, libraries, the legislature, the Governor's Office.

Legislation—The Ed-Net Planning Committee was created in 1987; in 1988, the legislature approved $8 million to begin Ed-Net.

Current State/local efforts:

- The Northwest Regional Education Laboratory is 1 of 10 teacher training centers for the TERC Star Schools project.
- Portland Community College and Chemekita Community College operate ITFS systems.
- Some schools in the State receive programming from TI-IN.

Future/planned activities:

- Ed-Net is a statewide telecommunications network (emphasis on satellite delivery) under development for all sectors of education as well as business and industry, State agencies, and community organizations.

Pennsylvania

State planning—SEA, Pennsylvania Public Television Network.

Other institutions involved in planning—Pennsylvania State University (PSU).

Current State/local efforts:

- The Pennsylvania Teleteaching Network, operated by Mansfield University, is an audiographics network that links 48 sites in Pennsylvania, Utah, South Dakota, North Dakota, and Mexico.
- Penn-Link is a statewide K-12 computer network offering data exchange, bulletin board services, and electronic mail.
- PSU and Mind Extension University are cooperating to offer professional development programming to educators via cable television. PSU also uses public television, cable television, microwave, and satellites to deliver programming statewide.
- The Philadelphia School District is wiring 16 schools for complete cable television access.
- Some schools in the State receive programming from Oklahoma State University's ASTS.

- The State is a member of SERC.

Future/planned activities:

- The Philadelphia School District has joined with Dallas, San Francisco, Chicago, and New York City school districts to develop a satellite network for linking urban schools.

Rhode Island

State planning—None at the K-12 level.

Other institutions involved in planning—Office of Higher Education, public television, SEA.

South Carolina

State planning—South Carolina Educational Television (SCETV) coordinates educational telecommunications for the Department of Education.

Other institutions involved in planning—SEA, University of South Carolina, State agencies.

Current State/local efforts:

- SCETV uses broadcast television and an extensive ITFS network to transmit programming (primarily instructional television series and staff development) to public schools. SCETV also conducts teleconferencing via satellite and microwave with audio bridges. SCETV is a major producer of programming for SERC.
- The eight campuses of the University of South Carolina and South Carolina State College collectively offer more than 90 college credit classes over broadcast television.
- The SERC Star Schools project is based in South Carolina. This project delivers live interactive instruction via satellite to students and teachers in 19 States and 4 associate cities.

Future/planned activities:

- University of South Carolina and Mind Extension University are planning a professional development program for library media specialists.

South Dakota

State planning—The Interactive Telecommunications Committee was formed in January 1989 with representatives from K-12, higher education, State government, and US West. The committee completed a needs assessment for telecommunications and is preparing a feasibility study for the State. The Board of Directors for Educational Television, an agency of SEA and Department of Cultural Affairs, is also involved in planning.

Current State/local efforts:

- The Technology in Education project is a statewide telecommunications consortium of school administrators exploring the uses of telecommunications for delivering foreign language and other instruction. Five sites are operating.
- Several schools in the State have participated in the Pennsylvania Teleteaching Project, which connects schools via audiographics.
- Some schools in the State receive TI-IN programming.

Future/planned activities:

- The Interactive Telecommunications Network being developed will provide compressed video, audio, and data services to K-12, higher education, and State government agencies. Eventually, services will be extended to business and industry.

Tennessee

State planning—SEA.

Other institutions involved in planning—Board of Regents, Public Utilities Commission.

Current State/local efforts:

- Sixteen districts in six northeastern counties have formed the Upper East Tennessee Educational Cooperative. The system will use microwave, cable television, and satellite to link schools and off-campus centers in the counties with East Tennessee State University. Future plans are to serve local business, the Department of Corrections, and the University's Medical School. Funds for the system have been provided by the State, the U.S. Department of Commerce Public Telecommunications Facilities Program, and the Tennessee Valley Authority.
- Some schools in the State receive programming from Oklahoma State University's ASTS.

Future/planned activities:

- SEA is planning a statewide needs assessment and inventory of educational telecommunications resources.
- State funding will be used to install satellite receiving equipment at 14 sites. These sites and others will receive programming from TI-IN. SEA plans to have a satellite dish in every school system to deliver courses and staff development.

Texas

State planning—SEA, State Board of Education, Coordinating Board for Higher Education. The *1988-2000 Long-Range Plan for Technology*, completed in 1988, includes a needs assessment and recommendations for distance education.[8] The Automated Information and Telecommunications Council oversees the development and operation of the State's telecommunications facilities.

Other institutions involved in planning—Education Service Centers (ESC), TI-IN, universities.

Legislation—Required and funded the development of the *1988-2000 Long-Range Plan for Technology*. The Public Education Technology Act of 1989 (proposed) requests $16.65 million to implement the plan.

Current State/local efforts:

- The InterAct Instructional Television Network, operated by the Region IV Education Service Center in Houston, uses ITFS/microwave and telephone to deliver courses and programming to students and teachers in 38 districts.
- The South Oak Cliff Project uses audiographics to deliver courses to students in the Dallas Independent School District.
- The Region 9 ESC in Wichita Falls uses prerecorded videotapes supplemented by audio exchange to deliver instruction.
- The Dallas Independent School District (DISD) is wiring all classrooms for cable television, computer, and phone access.
- TI-IN, in collaboration with ESC Region 20 (San Antonio), provides live satellite-delivered courses to students and teachers at over 700 sites in 22 States. TI-IN also operates the TI-IN United Star Network, one of the four federally funded Star Schools projects.
- Texas is a member of SERC.
- Some schools in the State receive programming from Oklahoma State Unversity's ASTS.

Future/planned activities:

- The State's plan for educational technology recommends increased funding for modems, computers, and connect time to put all districts on an electronic network. The plan also requests 200 new satellite downlinks and funding for educational program development.
- DISD has joined with the school districts in New York City, Chicago, Philadelphia, and San Francisco to develop a satellite network to serve urban schools.

Utah

State planning—SEA; the Utah Telecommunications Cooperative includes representatives from the major universities, SEA, the State Board of Regents, and several State agencies. The cooperative coordinates telecommunications planning for the State. Educational programming delivered via telecommunications is coordinated by the State Educational Telecommunications Organizing Center (SETOC).

Other institutions involved in planning—Utah Higher Education, Regional Educational Service Centers, Board of Regents, colleges and universities.

Current State/local efforts:

- EDNET, the State's microwave system, provides two-way audio/video instruction to high school and college students and teachers around the State. The system is also used for teleconferencing and data communication.
- The Intermountain Community Learning and Instructional Services project, operating out of Utah State University, uses audiographics to deliver instruction to high school students and teachers in four schools in each of Montana, Wyoming, Utah, and Colorado.
- The Carbon County School District Distance Learning Project links one elementary school, one junior high school, two high schools, and the College of Eastern Utah in a fully interactive two-way cable/microwave system with data transmission capabilities.
- The Central Utah Educational Services project transmits an Advanced Placement (AP) English class from Richfield High School via microwave to KUED-TV, where it is broadcast live to five high schools.
- Davis County uses audiographics to deliver an AP physics class to three high schools.
- The Mansfield-Utah Tele-teaching Project links the Garfield County School District with Mansfield University and the Southern Tioga School District in Pennsylvania via audiographics.
- The Northeastern Utah Educational Service Telelearning Project connects five high schools and a vocational center with audiographics delivered via the State's microwave backbone (when possible) and the phone system.
- In the San Juan School District Techno-teaching Project, four high schools serving Native American students are linked together by two-way microwave.
- The Tele-teaching in the Great Basin project links eight high schools in four districts using audiographics.

Vermont

State planning—Governor's Educational Technology Committee, Vermont Technical College.

Other institutions involved in planning—University of Vermont, SEA, New England Telephone.

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[8] In 1987, prior to the completion of the long-range plan, the Texas Education Agency prepared a *Guide to Distance to Distance Learning as an Alternative Procedure* (Austin, TX: 1987) and a companion document, the *Distance Learning Proposal* (Austin, TX: 1987).

Current State/local efforts:

- The Northeast Kingdom Rural Telecommunications Cooperative brings together eight elementary and three high schools with cooperation from the two local electric cooperatives. Live interactive audio/video instruction can originate from any site and is transmitted via satellite to other schools.
- Vermont Interactive Television is a joint venture involving Vermont Technical College, the Vermont State Colleges, SEA, the North County Area Vocational Center, New England Telephone, and various State agencies. The system uses fiber optics to connect 6 sites around the State; 16 more sites are planned for next year. The system offers interactive audio/video services to education and business.
- Some schools in the State also receive programming from Oklahoma State University's ASTS.

Future/planned activities:

- Universities in Vermont, Maine, and New Hampshire are working with New England Telephone to create a Northern Tier Network that would use fiber optics and satellite capabilities to allow the States to share programming.

Virginia

State planning—The Division of Educational Technology in the Department of Information Technology coordinates all educational telecommunications. SEA is developing a 5-year plan for educational technology; a needs assessment is being conducted. The Council of Higher Education's Task Force on Telecommunications issued a "Report on Telecommunications" in September 1987.

Other institutions involved in planning—Public television stations, Public Telecommunications Council.

Current State/local efforts:

- Fairfax County is involved in several projects. Local students participated in a teleconference with students in China. The county produces over 100 hours of live interactive broadcast instructional series, and produces science seminars for the SERC Star Schools project.
- The University of Virginia (UVA) operates Teacher Link, a local computer bulletin board service that links student teachers with their professors and peers. The system serves 80 teachers and 40 student teachers in two districts, and by 1990 will serve all student teachers in 7 districts. UVA is also a partner in the TERC Star Schools project, serving as 1 of 10 regional teacher training centers.
- The Varina High School Electronic Classroom is a cooperative project between SEA and the Henrico County School System. Live courses are transmitted through a combination of cable, microwave, and ITFS from the classroom at Varina to 30 school districts.
- WHRO-TV (public television) in Norfolk is constructing a regional ITFS network that will serve education and business, and is connected to Old Dominion University by fiber optics. The station also has satellite transmitters and receivers and microwave facilities that are used for education.
- Virginia is a member of SERC Star Schools project.

Future/planned activities:

- SEA plans to have a satellite downlink at every secondary school by September 1989, and plans to build another electronic classroom.

Washington

State planning—SEA and the Higher Education Coordinating Board (HECB). A joint "Educational Telecommunications Plan for K-12/Higher Education" was completed in October 1988, and a "Report to the Legislature on Linking for Learning: K-12 Educational Telecommunications Plan" was presented to the legislature in January 1989. The Department of Community Development (DCD)/Department of Information Services (DIS) has produced a report on statewide video telecommunications needs and resources, and SEA, HECB, and DCD/DIS are cooperating on a Statewide Telecommunications Network Plan.

Other institutions involved in planning—DIS coordinates statewide planning for telecommunications.

Legislation—Legislation in 1987 required SEA and HECB to develop a joint plan for a statewide educational telecommunications network by June 1989. Separate legislation enacted the Washington State Video Telecommunications Project requiring DCD to conduct a needs and resource assessment for a statewide video telecommunications system by January 1989.

Current State/local efforts:

- The Satellite Telecommunications Educational Programming (STEP) project is operated by Education Service District 101 in Spokane. STEP delivers live instruction via satellite (one-way video, two-way audio) to high school students and teachers in more than 100 districts in 8 States.
- Some schools in the State receive TI-IN programming.
- Some schools in the State also receive programming from Oklahoma State University's ASTS.

Future/planned activities:

- The proposed K-12 telecommunications system will provide every district, the nine educational service districts, and SEA with satellite receiving equipment, and will provide funds for student and teacher programming.

West Virginia

State planning—SEA is conducting a telecommunications needs assessment and is preparing a technology survey of teachers and administrators.

Other institutions involved in planning—Superintendent's Technology Study Group, West Virginia Distance Learning Users' Group, West Virginia Public Broadcasting Authority, Board of Regents, West Virginia University.

Current State/local efforts:

- In the State, 79 schools receive programming via satellite from a variety of sources including TI-IN, SERC, and Oklahoma State University.
- Two computer networks, WVMEN and WVNET, serve K-12 schools and higher education.
- The State is a member of SERC.

Wisconsin

State planning—The Wisconsin Educational Communications Board (WECB) coordinates telecommunications planning. The Council on Instructional Telecommunications, appointed by SEA, has developed policy recommendations for the State.

Other institutions involved in planning—SEA, University of Wisconsin has completed a review of educational telecommunications needs for the 26 campus system, vocational-technical institutes.

Current State/local efforts:

- The Wisconsin Rural Reading Improvement Project is a collaborative effort between SEA, Wisconsin Public Radio and Television Networks, three Cooperative Educational Services Units, Viterbo College, and 18 local districts. Programming and services (including inservice and computer networking) are delivered via television, radio, ITFS, and the telephone system.
- WECB operates a statewide educational television broadcast network and is constructing ITFS systems for program delivery to campuses of the University of Wisconsin system, elementary and secondary schools, and vocational-technical schools.
- The University of Wisconsin operates the Educational Teleconferencing Network.
- The State vocational-technical institutions have an ITFS network.
- The State is a member of SERC.
- Some schools in the State receive programming from TI-IN.
- Some schools in the State also receive programming from Oklahoma State University's ASTS.

Future/planned activities:

- WECB is planning to develop a satellite delivery service for statewide educational programming that may also reach other States.

Wyoming

State planning—Governor's Telecommunication Division. State policy permitting distance learning took effect last year, and a report to the legislature by the Education Policy Implementation Committee is due in December 1989.

Other institutions involved in planning—University of Wyoming, State agencies, colleges and universities.

Current State/local efforts:

- The Governor's Telecommunication Division operates a statewide computer conferencing network that uses audiographics to reach eight sites. Plans call for the system to be extended to all 23 counties in the State. The University of Wyoming may use the system to teach college courses, while various State agencies may do employee training.
- The Intermountain Community Learning and Instructional Services, operating out of Utah State University, uses audiographics to deliver instruction to high school students and teachers in four schools in each of Montana, Wyoming, Utah, and Colorado.
- Six districts receive programming from TI-IN.

Appendix B

Sample Costs of Transmission Systems

Costs for distance learning transmission systems vary widely depending on system design and complexity, range and scope, capacity, large volume purchase agreements, and lease v. buy options. In general, the declining costs of electronic components have made telecommunications equipment more affordable. Continued declines in prices are expected.

Costs can be divided into two basic categories, initial costs including transmitting and receiving equipment, and continuing costs such as programming and operation. Not all schools will face all these costs. Some schools can take advantage of existing telecommunications resources to cut costs, while other schools may have to build a completely new transmission system. Schools sharing existing teaching resources and using local facilities may have low programming costs, while schools receiving programming from outside providers will face higher expenditures. Finally, costs can differ greatly between those who only receive programming and those who originate and transmit it. In a satellite system, for example, production and transmission facilities can cost millions of dollars. Costs to the local schools, however, are much lower, several thousand dollars for hardware, $5,000 to 10,000 for subscription and tuition fees, and any local personnel costs.

The costs described below are only sample costs for basic systems. These costs, therefore, should serve as only a rough guide to distance education transmission costs.

Instructional Television Fixed Service (ITFS)

ITFS is a relatively low-cost way of delivering one-way video to multiple remote sites.

Transmit Sites

200 ft. transmitting tower	$50,000
transmitter (one for each channel)	$15,000-20,000
transmitting antenna	$10,000-15,000
miscellaneous electronics	$10,000

(A rough figure for a transmit site is $60,000, not including the tower)

Receive Sites

receive antenna and tower (costs are based on the height of tower needed for reception; higher towers cost more)	$3,000-$50,000
downconverters and electronics	$350-$3,000
ITFS voice response system	$2,500-5,000

Operating costs for ITFS are minimal compared other broadcast technologies. For example, the system ru by WHRO in Norfolk, Virginia, consists of one hu location and seven repeater stations broadcasting fo channels of ITFS. The annual operating cost, includin salaries for personnel and technical support, is $213,00 The average cost per hour of transmission is $45.[1]

Satellite

Transmission Costs

A complete uplink facility, including studio and a electronics, can cost between $500,000 and $1 millio Some providers have their own facilities, while othe lease. Added costs associated with uplink facilitie include operating and personnel costs, and the cost o getting the signal from the originating site to the uplink

Transmission time for satellite delivery is based on th time and capacity desired. The cost of satellite transmission is distance insensitive. Unlike the telephone syste which charges by the mile, satellites reach anywhere i their footprint with no higher cost to transmit 2,000 mile than for 200. Type of satellite (C- or Ku-band) and tim of day (prime or nonprime time) also affect the cost o transponder time. Lower rates are frequently available fo those users willing to commit to long-term contracts o minimum numbers of hours per year. C-band time range from under $200 per hour up to almost $500. Ku-ban prices also start under $200 and range up to $600 per hour

Pricing can be flexible, allowing users to lease only th capacity or amount of time they need. A full transponde leased 24 hours per day can cost $170,000 per month while leasing only a portion of the transponder can cost a little as $5,200 per month. Most educational users bu time on an "occasional use" basis, meaning that they bu a full transponder, but for only a certain number of hour per day.

Receive Site Costs

Satellite downlinks cost from $800 to $18,000 depending on the type (C or Ku) and features required. Som factors affecting cost include: voice, data, and vide capabilities; receive only or send/receive; and local sit requirements including fencing around the dish an cabling to connect the dish to the user premises. Steerabl dishes, which allow users to aim at many satellites, cos three or four times as much as fixed dishes, which remain aimed at a particular satellite.

C-band receive-only downlinks	$5,000-$10,00
Ku-band receive-only downlinks	$800-$5,00
C/Ku-band receive-only downlinks	$8,00

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[1] Richard Daly, Narrowcast Services Manager, WHRO Norfolk, VA, personal communication, Apr. 25, 1989.

In some cases, schools can obtain volume discounts through a State-arranged contract or through arrangements made by programming providers.[2]

Programming Costs

Subscription rates are another (ongoing) cost associated with satellite delivery of educational services from multistate providers. For example, an annual subscription to TI-IN is $5,050, courses cost $240 per student per semester (with $50 for additional students over a set limit), and staff development costs between $2,200 to $8,000 per year depending on district size.

Cable

Basic cable television connections for schools are often provided free to schools as part of the local cable franchise agreement. A single cable drop, however, often reaches only one location in a school. Complete internal wiring for cable reception can be very expensive. The Dallas Independent School District is in the process of wiring all classrooms in 235 schools with both cable and telephone (data communication) lines at a cost of $3.8 million. When completed, the system will deliver 30 cable television channels to each classroom. The system will also make four video return channels available, and allow two-way data transmission for administration and computer networking.[3]

The initial cost for an interactive cable system depends on how much work is required to add two-way capability to the system. Additional equipment needed to bring the signal back upstream will increase costs.

Initial Costs

coaxial cable installation	$18,000-$25,000 per mile[4]
modulators	$500-$2,000
demodulators	$2,000-$4,000
reverse flow amplifiers (for two-way capability)	$3,500[5]

Ongoing or operational costs also vary. There are no transmission costs in systems that use the public or an institutional cable system. Maintenance budgets average between 2 and 5 percent of system cost, but will likely increase as the system ages.

Microwave

Since each site in a point-to-point microwave system is both a transmit and a receive site, the cost of installing and operating a microwave system can be relatively high. Duplex microwave systems cost between $40,000 and $65,000 per channel, including transmitters, receivers, and all electronics. Adding additional channels can cost almost as much.[6]

Microwave towers vary widely in cost. One New York State study identifies costs ranging between $100,000 and $150,000 each.[7] Others report costs for short-haul towers at $5,000 to $50,000, and longer spans requiring bigger towers range from $25,000 to $75,000 each.[8] However, tower costs could be reduced or eliminated by using existing towers or placing multiple antennas on a single tower. Insurance, maintenance, and repairs can average between 3 and 5 percent of system cost per year.[9]

Public Switched Telephone Network (PSTN)

Start-up costs for using PSTN to deliver distance education can be very low. All that most users will have to pay are usage, access charges, and installation. However, line termination charges for each site can run into thousands of dollars, and installation charges can be very high if many of the school's classrooms have to be wired.[10] (See the example of the Dallas Independent School District in the Cable Cost Section.) The telephone company bears the cost for all equipment outside the school, including most upgrades, maintenance, and repair, as well as the transmission hardware.

Transmission costs on PSTN depend on the length and duration of the call and the type of line used. Local telephone transmission costs also vary from State to State, and can add a significant amount to ongoing system costs.[11] In Texas, for example, terrestrial voice/data (56 kbps) costs public institutions 52 cents per mile per month. For the higher capacity T1 lines (1.544 Mbps), which can carry limited (compressed) motion video, the cost is $12.49 per mile per month. Long distance charges will increase costs significantly.

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[2] For example, a complete receive site for the Missouri Educational Satellite Network costs $8,000 which includes: dual frequency antenna, receiver, data controller, VCR, color monitor, printer, equipment rack, and speaker phone. Maintenance is offered for $300 per year.

[3] Diana Radspinner, coordinator of cable communications, Dallas Independent School District, personal communication, Aug. 16, 1989.

[4] Robert Luff, vice president for technology, Jones Intercable, personal communication, August 1989.

[5] Richard Labrie, executive director, South Berkshire Education Collaborative, personal communication, May 5, 1989.

[6] Jack Beck, WHRO, Norfolk, VA, personal communication, Apr. 10, 1989; Karen Kitchen and Will Kitchen, *Two-way Interactive Television for Distance Learning— A Primer* (Alexandria, VA: National School Boards Association, May 1988), p. 19; Linda Lloyd, "Telecommunications and Distance Learning: Trends in the U.S.," paper presented to the American Educational Research Association 1988 Annual Meeting, Apr. 5-9, 1988, New Orleans, LA.

[7] New York State Legislative Commission on Science and Technology, *Distance Learning: The Sky's the Limit* (Albany NY: August 1988), p. 11.

[8] Kitchen and Kitchen, op. cit., footnote 6, p. 19.

[9] Ibid.; New York State Legislative Commission on Science and Technology, op. cit., footnote 7, p. 11.

[10] The Telecommunication Technical Advisory Committee, "A Report to the Texas Higher Education Coordinating Board," unpublished document, November 1988, p. 5.

[11] E. Kent Ellerston, "Report on Distance Learning: A National Effectiveness Survey," prepared for the Pennsylvania Teleteaching Project, December 1987, p. 9.

Distance learning systems requiring simultaneous communication among multiple sites may need an audio or data bridge. These bridges can either be purchased ($1,000 to $2,000 per port—each port represents one line per user that can access the bridge), or rented through services such as AT&T's Alliance Teleconferencing Service, which charges 25 cents per port per minute. On this system, for example, a three-way 1-hour call would cost $45.

Fiber Optics

The cost of constructing a fiber optic system is relatively high, but is expected to decrease rapidly as electronics and cable costs decline. The cost of fiber cabling is widely expected to fall below that of coaxial or copper cabling by the early 1990s.[12] The cost to connect an individual household or school to the public network is approximately $1,200 for copper and $1,500 for fiber for new construction.[13] In general, the price of electronics is steadily declining,[14] and the cost of fiber optic technology should continue to drop as economies of scale are realized.[15]

analog transmitters and receivers	$12,000
repeaters (spacing varies)	$24,000
laser modulators	$2,000-3000
coders/decoders (codecs)	$8,000-60,000 (depending on capability)

Additional termination equipment at each site can cost up to $45,000.[16]

Sample Fiber Optic Contract Agreements[17]

Northwest Education Technology Cooperative

10-year lease with a national telephone company
10-year renewal period option
70-mile network
$28/mile/month lease rate includes all maintenance
2 dark (unused) fibers
Schools own terminal equipment
Prohibited from T-1 and bypass use

Pottowattomie County, Oklahoma

5-year lease with the local telephone company and renewal periods of 5 years thereafter based on maintenance expense and rate of return regulation
18-mile network
$70/mile/month including most maintenance
2 dark fibers
Schools own terminal equipment
Prohibited from T-1 and bypass use

Girard, Kansas

15-year lease with local telephone company with 15-year renewal
60-mile network
$38/mile/month includes maintenance
2 dark fibers
Schools own terminal equipment
Prohibited from T-1 and bypass use

Dodge Center, Minnesota

7-year lease with a national telephone company and annual renewal period
60+ mile network (not complete)
$53/mile/month including all maintenance
2 dark fibers
Schools own terminal equipment
Prohibited from T-1 and bypass use

Big Fork, Minnesota

Direct ownership with four local telephone companies and one long distance carrier
134-mile network
$8,955 per mile including some maintenance
2 dark fibers
Schools own terminal equipment
Prohibited from bypass use

Computer-Based Applications

Compared to other technologies used for distance learning, computer-based systems can have relatively low start-up costs.

personal computers	$1,200-$5,000
modems	$300
graphics tablets	$400
scanners	$1,500
printers	$300-2000
software for communication/ audiographics	$0-3,500

Total costs per site are under $10,000.

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[12] U.S. Department of Commerce, National Telecommunications and Information Administration, *NTIA Telecom 2000* (Washington, DC: U.S. Government Printing Office, October 1988), p. 76.

[13] Robert M. Pepper, *Through the Looking Glass: Integrated Broadband Networks, Regulatory Policy and Institutional Change* (Washington DC: Federal Communications Commission, November 1988), p. 8.

[14] National Telecommunications and Information Administration, op. cit., footnote 12, p. 220.

[15] "In a report on fiber deployment released in January of 1988, the Federal Communications Commission noted that a 50 percent decrease in the cost of electronics is typical, and that fiber itself has declined in price by approximately 50 percent over the past six or seven years." Andrew C. Barrett, "The Potential of Fiber Optics to the Home: A Regulator's Perspective," *Public Utilities Fortnightly*, Jan. 19, 1989, p. 15.

[16] Kitchen and Kitchen, op. cit., footnote 6, pp. 20-21.

[17] The following examples were provided by Dennis Pellant, executive vice president, Tele-Systems Associates, Inc., Bloomington, MN.

Transmission costs associated with computer conferencing and audiographic systems are the costs of using the public telephone system. (See the cost section on PSTN). The costs of wiring all classrooms with data connections (telephone jacks) can be high, especially for schools having to wire existing classrooms. Packet radio modems may help schools avoid some of this cost.[18] Wiring done at the time the building is constructed is less expensive. Installation charges will depend on the arrangements made with the service provider (the telephone company, cable, or other independent contractor).

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[18] A device has been developed using packet radio technology, which essentially functions as a wireless/radio modem allowing computers in any part of the school building to access outside phone lines with out being physically connected to them. The modem at each computer wirelessly communicates with another radio modem that is connected physically to one of the school's telephone jacks, thus allowing communication anywhere in the school building without the necessity of expensive wiring. Each unit (two are required, just as with traditional modems) may cost $600.

Appendix C

Glossary

ACTS (Advanced Communications Technology Satellite): A National Aeronautics and Space Administration Ka-band satellite that is scheduled for deployment in the early 1990s.

Addressable converter: A device connected to a television set that allows cable television operators to turn on or block individual subscriber access to pay-per-view services.

Amplifiers: Electronic devices, spaced at intervals (cascaded) throughout a cable television system, used to boost the strength of the cable signal as it passes from the headend to the subscriber. In coaxial cable systems, amplifiers are needed approximately every 1,500 feet.

Analog communication: A communication format in which information is transmitted by modulating a continuous signal, such as a radio wave. *See also* Digital communication.

Asynchronous communication: Two-way communication in which there is a time delay between when a message is sent and when it is received. Examples include electronic mail and voice mail systems.

Audio bridges: Electronic devices that connect and control multiple telephone lines for audio and data applications, allowing many callers to be connected as a group simultaneously. Used for audioconferencing.

Audioconferencing: An electronic meeting in which participants in different locations use telephones to communicate simultaneously with each other.

Audiographics: An advanced computer application in which computer interaction is augmented by two-way, real-time audio communication. Audio, data, and graphics are shared over regular telephone lines, allowing users in different locations to work on the same application simultaneously.

Bandwidth: The width of frequencies required to transmit a communications signal without undue distortion. The more information a signal contains, the more bandwidth it will need to be transmitted. Television signals, for example, require a bandwidth of 3 million hertz (cycles per second), while telephone conversation needs only 3,000 hertz.

Bit (BInary digiT): the smallest unit of information a computer can use. A bit is represented as a "0" or a "1" (also "on" or "off"). A group of 8 bits is called a byte. Bits are often used to measure the speed of digital transmission systems.

Bell Operating Companies (BOCs): As a result of the divestiture of AT&T in 1984, the original Bell telephone system was divided into 22 local Bell Operating Companies that now provide local telephone service across most of the country. These companies are controlled by the seven "Baby Bells," the Regional Bell Operating Companies (RBOCs).

Bulletin board service (BBS): A computer service that allows remote users to access a central "host" computer to read and post electronic messages. Communication is usually asynchronous.

C-band: The designation for satellite communications operating at 6 GHz (billion cycles per second) uplink and 4 GHz downlink. These frequencies are also used for terrestrial microwave transmission.

Coaxial cable: Shielded wire cable that connects communications components together. It is commonly used in cable television systems because of its ability to carry multiple video (or other broadband) signals.

Codecs: The abbreviated form of "coder-decoder." Electronic devices that convert and compress analog video signals into digital form for transmission, and convert them back again on reaching their destination.

Compact disc-read only memory (CD-ROM): An optical storage system for computers that only allows data to be read off the disc. New data cannot be stored and the disc cannot be erased for reuse.

Compressed video: A video signal requiring less information to transmit than broadcast quality or full-motion video. Digital technology is used to encode and compress the signal. Picture quality is generally not as good as full-motion; quick movements often appear blurred. Compressed video requires transmission speeds between 56 kbps and 2.0 Mbps.

Computer conferencing: Allows individuals at different locations to communicate directly with each other through computers. Communication may be in real time or delayed.

Digital communications: A communications format used with both electronic and light-based systems that transmits audio, video, and data as bits ("1s" and "0s") of information (*see* Bit). Codecs are used to convert traditional analog signals to digital format and back again. Digital technology also allows communications signals to be compressed for more efficient transmission.

Digital video interactive (DV-I): A system that combines audio, data, and limited-motion video on an optical disc. DV-I will run on a personal computer, allowing the user to control interactive programs.

Direct broadcast satellites (DBS): Satellites that operate in the 12.2 to 12.7 GHz frequency band. These satellites are designed to broadcast programming directly to small (1 meter) home receiving dishes. No such services are currently operating in the United States.

Downlink: An antenna shaped like a dish that receives signals from a satellite. Often referred to as a dish, terminal, Earth station, TVRO (television receive only).

Downstream: The direction a signal travels as it moves from the transmitting (origination) site to the receiving sites.

Electronic blackboard: A computer application that allows graphics to be shared among many computers simultaneously. Each user can see and annotate the graphics as needed. The results will be visible to all users.

Facsimile machine (fax): A telecopying device that electronically transmits written or graphic material over telephone lines to produce a "hard copy" at a remote location.

FCC: Federal Communications Commission.

Fiber optics: Hair thin, flexible glass rods that use light signals to transmit audio, video, and data signals. Signals can be sent in either analog or digital format. Fiber optic cable has much higher capacity than traditional copper or coaxial cable, and is not as subject to interference and noise.

Footprint: The area on the Earth's surface to which a satellite can transmit. Different satellites cover different areas and have different footprints. Satellite footprints generally cover all the continental United States (full conus) or only half of it (half conus coverage).

Freeze frame: One method of transmitting still images over standard telephone lines. A single image is transmitted every 8 to 30 seconds. Also referred to as slow scan.

Frequency: The number of times per second an electromagnetic wave completes a complete cycle. A single hertz (Hz) is equivalent to one cycle per second.

Full-motion video: A standard video signal that can be transmitted by a variety of means including television broadcast, microwave, fiber optics, and satellite. Full-motion video traditionally requires 6 MHz in analog format and 45 Mbps when encoded digitally.

Gbps: Giga (billion) bits per second. *See* Bit.

GHz: One billion hertz (cycles per second). *See* Frequency.

Graphics tablet: A computer device resembling a normal pad of paper that users draw or write on. The graphics tablet converts hand-drawn images into digital information that can be used and displayed by a computer.

Headend: In a cable television system, the headend is the central transmission office from which programming is distributed to subscribers.

High definition television (HDTV): An advanced television system that produces video images as clear as high-quality photography. HDTV is still experimental in the United States.

Instructional Television Fixed Service (ITFS): A band of microwave frequencies set aside by FCC exclusively for the transmission of educational programming. Allows broadcast of audio, video, and data to receive sites located within 20 miles. Receive sites require a converter that changes signals to those used by a standard television set.

Integrated Services Digital Network (ISDN): An end-to-end digital network that will allow users to send voice, data, and video signals over the same line simultaneously. Narrowband services now in operation give users up to 24 channels to send voice and data information, with a combined capacity of up to 1.544 Mbps. In the future, broadband services available over a public ISDN are expected to offer full-motion video services as well.

Ka-band: Satellite communications frequencies operating at 30 GHz uplink and 20 GHz downlink.

Kbps: Kilo (thousand) bits per second. *See* Bit.

KHz: Kilohertz; thousand cycles per second. *See* Frequency.

Ku-band: Satellite communications frequencies operating at 14 GHz uplink and 12 GHz downlink.

Light emitting diodes (LEDs): Used as transmitters in some fiber optic systems. They transmit digital bits as pulses of light along a fiber optic strand.

Limited-motion video: *See* Compressed video.

Mbps: Mega (million) bits per second. *See* Bit.

MHz: Megahertz; million cycles per second. See Frequency.

Microwave: High-frequency radio waves used for point-to-point and omnidirectional communication of audio, data, and video signals. Microwave frequencies require direct line-of-sight to operate; obstructions such as trees or buildings distort the signal.

Modem (modulator/demodulator): A device that converts digital computer signals into analog format for transmission.

Modification of Final Judgment (MFJ): The 1984 agreement that brought about the divestiture of AT&T, and limited the Bell Operating Companies' involvement in manufacturing and designing equipment, as well as their ability to provide long distance and information services.

Modulation: The process of encoding audio or video signals onto a radio wave (carrier frequency) for transmission.

Multiplexer: A device that combines multiple signals for simultaneous transmission over a single channel.

Multipoint distribution services (MDS): Also MMDS; Multichannel Multipoint Distribution Service. Also known as "wireless" cable. A telecommunications service that uses microwave signals to transmit video entertainment and data.

Public Switched Telephone Network (PSTN): The public telephone network.

Real-time communication: Two-way simultaneous communication, as opposed to asynchronous.

Repeater: A device used to extend the range of a communication signal.

Reverse flow amplifier: In two-way cable television systems, these devices move video and audio signals from the receive sites back to the cable headend.

Signaling System 7 (SS7): A recent development in control systems for the public telephone network. It allows telephone company computers to communicate with each other, making telephone call processing faster and more efficient and enabling more services to be made available to consumers.

Slow scan: *See* freeze frame.

Steerable dish: A satellite receive dish that uses motors to rotate the dish to receive signals from many satellites. "Fixed" dishes are stationary, always pointed at the same satellite, unless reaimed by hand.

Switched network: A type of system where each user has a unique address (such as a phone number), which allows the network to connect any two points directly.

T1 rate: A digital transmission speed of 1.544 Mbps.

Teleconferencing: A general term for any conferencing system using telecommunications links to connect remote sites. There are many types of teleconferencing including: videoconferencing, computer conferencing, and audioconferencing.

Television receive only (TVRO): Satellite dishes only capable of reception.

Touch screen: A computer screen that allows data to be entered by using a specialized pen to write on the screen, or by making direct physical contact with the computer screen.

Transponder: The electronic equipment on a satellite that receives signals from an uplink, converts the signals to a new frequency, amplifies the signal, and sends it back to Earth. Satellites are usually equipped with 12 to 24 transponders.

Uplink: A satellite dish that transmits signals up to a satellite.

Upstream: The direction a signal travels as it moves from a receive site back to the site of original transmission. Used especially in two-way cable television systems.

Vertical blanking interval (VBI): The unused lines in a standard television signal. The VBI appears as a black band at the top or bottom of a television picture. Often used for closed captioning.

Very small aperture terminals (VSATs): Satellite receive dishes, approximately 1.8 to 2.4 meters in diameter, that are capable of sending and receiving voice, data, and/or video signals.

Videophone: A telephone combined with a video screen, allowing callers to see each other as they speak.

Appendix D

Contractor Reports

Copies of contractor reports done for this project are available through the U.S. Department of Commerce, National Technical Information Service (NTIS), Springfield, VA 22161, (703) 487-4650.

1. Bruce O. Barker, Texas Tech University, "Distance Learning Case Studies."
2. Richard E. Clark, University of Southern California, "Evaluating Distance Learning Technology."
3. Christopher Dede, University of Houston—Clear Lake, "The Evolution of Distance Learning: Technology-Mediated Interactive Learning."
4. Donald C. Holznagel and Thomas Olson, The Northwest Regional Educational Laboratory, "A Study of Distance Education Policies in State Education Agencies."
5. Michael G. Moore, Pennsylvania State University, "Effects of Distance Learning: A Summary of the Literature."
6. Jason Ohler, University of Alaska Southeast, Educational Technology Program, "Distance Education and the Transformation of Schooling: Living and Learning in the Information Age."
7. Lloyd O. Otterman and Pamela S. Pease, TI-IN Network, "The Role of Private Business in Distance Learning: The Educational Partnership."
8. Larry G. Patten, St. Louis Community College, "Technologies for Learning at a Distance: Looking to the Future Changing Educational Relationships."

Appendix E

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